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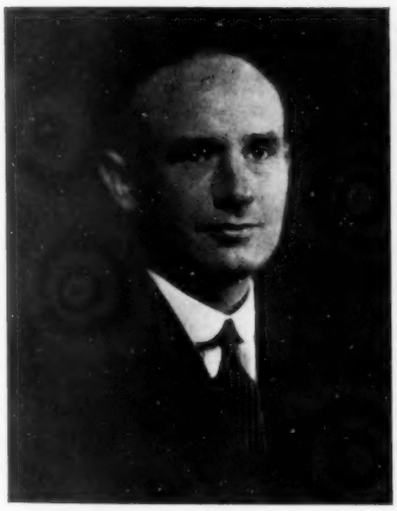
METAL INDUSTRY
FABRICATION · ASSEMBLING · PLATING · FINISHING
VOL. 37, NO. 7 JULY, 1939

To Arthur Wesley Hothersall

We have long regarded you as one of the world's keenest students of electrodeposition and your visit to America was awaited with high expectations. Your presentations of technical data, your discussions on many diverse phases of electrodeposition, and your charming personality have immeasurably exceeded our expectations. You have won the heart and goodwill of all who have met you.



As President of the Electrodepositors' Technical Society of England, you have done much to foster good-will with your American counterpart, the American Electroplaters' Society, as well as to acquaint its members with the high technical standards to which your society holds. In these times of international stress, the good-will engendered by your visit is doubly significant in cementing the human ties of the remaining democratic nations.

Let us hope that your visit is the start of repeated visits of your fellow scientists to our conventions and of America's to yours.

On Crystal Size Terminology

The discussions in the literature on crystal size of electrodeposits are beset with ambiguities. Loose mention is made of macroscopic surface finish as being either coarse or finely crystalline. Thus in discussing cyanide copper deposits, it is commonly stated that higher current densities cause coarsening of the crystals resulting in rough deposits. Actually the reverse may have happened. The coarser surface structure may be made of finer crystals which have grown in nodular structures due to foreign matter.

Microscopic determinations of crystal size of metals deposited from acid solutions may be relatively easy but even these may be made difficult when high current densities are used or when addition agents are employed.

The crystals of metals deposited from cyanide solutions are beyond the limit of resolution of the microscope, or if they are not, then the metallographic etchants are incapable of resolving grain boundaries. Obviously, therefore, talking about crystal size of deposits from cyanide or complex solutions is fraught with ambiguity.

The simplest terminology would be to say that the deposits are rough, coarse, fine, etc., and omit reference to crystal size unless definite information is available as to the sizes of the crystals concerned.

A homely example of the point which we wish to make is as follows: Let us assume that build-

ing bricks represent submicroscopic crystals—with these bricks could be built small or large structures and if viewed from a long distance off, the individual bricks could not be seen—only the structures (nodules or roughness in the surface). It would obviously be ridiculous to view these structures from afar and say the large structures were made of larger bricks (crystals) than the smaller. Actually the reverse could be true.

And thus it is with crystals, so let us not talk about their size until they have been seen or measured.

Federal Spending vs. Business

The fiscal year of the Federal Government which ended in June was one of the greatest spending years of all time with about one-seventh of our national income or more than nine billion dollars being spent. The seven years of spending a far larger proportion of our national income than that ever done in times of peace have not been as convincingly successful as we hoped.

The industrial production of 1938 in the United States was about 72% of the last great prosperity year, 1929. The United States had, in 1938, the lowest percentage of 1929 production of seventeen nations, in statistics recently published by the League of Nations. The data are:

Industrial Production in 1938
1929=100

Latvia	174.5
Japan	170.8
Finland	152.5
Sweden	146
Estonia	145.5
Chile	136.8
Denmark	135
Norway	127.2
Germany	126.2
Poland	117.3
United Kingdom	115.7
Italy	98.6
Canada	90.0
Netherlands	89.8
France	76.9
Belgium	75.1
U. S.	72.3

The relatively high production of some countries such as Japan, Germany and United Kingdom, may have been due in some degree to heavy armament programs but surely this cannot be true of all the nations listed, especially Latvia, Finland, Sweden and Estonia.

Canada suffered from the impact of the great depression as severely as did the United States, but during the recovery years, she has managed to have less relative unemployment and larger increases of production than this country, and she has done so with smaller proportional increases in her public debt.

Let us briefly consider federal spending vs. per capita production during the past 30 years:

From 1908 to 1915, the federal expenditures amount to only 2½% of our national income with a relative average per capita production of 79.

From 1915 to 1922, thus including the war, federal spending was 12.4% of national income with a per capita production of 89.

In the next eight years, federal spending declined until it was only 5.1% of national income and during that period the per capita production rose to 101. In those years, the federal spending not only met the cost of government, but it was sufficient to pay off a large part of the public debt incurred during the war.

In the past eight years, the expenditures of the federal government amounted to 12.1% of national income with an average per capita production of only 77, or less than it had been before the war when the costs of government were only 2½% of our national income.

It seems that our national well being fares better when the citizens do more spending and the government does less.

Electroplaters Hold Successful Convention at Asbury Park

The 27th Annual Convention of the American Electroplaters' Society held June 19-22 at Asbury Park, was the largest national meeting in the history of the Society, with 610 registrants.

The guests began to arrive early Sunday morning and by Monday morning, the facilities of the Berkeley-Carteret Hotel were thoroughly taxed to take care of the crowd which overflowed into the Hotel Monterey.

The entire program was run off smoothly and the papers presented at the educational session were of particularly high quality, and covered almost all fields of the plating

C. H. Proctor
Founder of A.E.S.
Presided at Monday technical session

industry. *Arthur W. Hothersall*, president of the Electrodepositors' Technical Society of England, presented the first technical paper on "Adhesion of Electroplated Coatings" at the Monday afternoon session, which was presided over by *Charles H. Proctor*, founder of the American Electroplaters' Society. An added feature of the Monday morning session was the presentation of technical papers by several English authors, in the form of records, which were played on the loudspeaker system. Thus, the members were able to hear the papers of Messrs. *Gardam*, *Francis-Carter* and *Clarke*.

Distinguished visitors from Canada were *Prof. J. T. Burt-Gerrans* of Toronto University, Toronto, and *Prof. J. U. MacEwan*, Birks Professor of

R. M. Goodsell
Supreme President

Frederick Fulforth
Supreme 1st Vice-President

Joseph L. Downes
Supreme 2nd Vice-President

Metallurgy, McGill University, Montreal. In addition to talks presented by the aforementioned authors, the Tuesday session was highlighted by the "Electrodeposition of Black Molybdenum Finishes," by Messrs. *R. O. Hull* and *R. A. Hoffman*. This paper won the Proctor Memorial Award of $100.

On Monday evening a large crowd

Nelson Sievering
Supreme 3rd Vice-President

of 605 people attended the party given by the International Fellowship Club. A buffet luncheon was served at 10 P.M., and dancing was enjoyed to the music of Dave Huggins and his orchestra until 2 A.M.

Technical sessions were held through Thursday morning and the presentations of papers were made with remarkable smoothness.

Election of Officers

At the business meeting, held Thursday afternoon, the following national officers were elected:

President: *R. M. Goodsell*, Racine Plating Company, Racine, Wisc.

First Vice-President: *Frederick Fulforth*, Proctor Electric Co., Philadelphia, Pa.

Second Vice-President: *Joseph Downes*, Remington-Rand, Middletown, Conn.

Third Vice-President: *Nelson Sievering*, Philip Sievering, Inc., New York.

W. J. R. Kennedy, Springfield, Mass., is Permanent Secretary.

Exhibits

The exhibit of plated goods was the largest and most comprehensive collection of examples of diverse phases of plating and finishing that has ever been assembled at a national meeting. *Paul Oldam*, Chairman of the Exhibits Committee, announced that all of the Branches of the Electroplaters' Society had exhibits at the meeting.

Prize Awards

The *A.E.S. Medal* was presented to *Dr. W. A. Wesley*, International Nickel Company, for his paper "Physical Properties and Uses of Heavy Nickel Deposits."

The *Founders' Gold Medal* was presented to *Walter C. Pinner* and *L. E. Borchert* for their joint paper on "The Importance of Proper Anode Corrosion in the Electrodeposition of Nickel."

The *Proctor Memorial Award of* $100 was given to *R. O. Hull*, E. I. duPont de Nemours & Co., Cleveland, Ohio, for his paper entitled, "Current Density Range Characteristics: Their Determination and Application."

The *Samuel Huenerfauth Cup* for the best branch paper to be presented, was awarded to *The Springfield Branch* for the paper "Answers to Some Questions on Cyanide Copper Plating," read by *D. S. Hartshorn, Jr.*

Dr. W. A. Wesley
A.E.S. Medal winner

D. S. Hartshorn, Jr.
Read Huenerfauth cup prize paper

Metal Industry Cup for the best exhibit was awarded to the *New Haven Branch.*

Individual Exhibit Awards: (1) *Thomas F. Slattery*, Baltimore-Washington Branch. (2) *S. J. Bart*, Newark Branch. (3) *L. A. Critchfield*, Philadelphia Branch. Honorable Mention, *Dr. C. B. F. Young*, New York Branch.

Dr. C. B. F. Young
Awarded honorable mention in individual exhibits award

International Fellowship Club

On Monday noon, the International Fellowship Club, held its annual luncheon with 107 representatives of industry being present which is 41 more than the largest previous at-

Thomas F. Slattery
Winner of individual exhibits award

L. A. Critchfield
3rd place winner of individual exhibits award

Jack Geissman

tendance at a similar meeting. At the luncheon, presided over by Chairman, *Oliver J. Sizelove*, Frederick Gumm Chemical Co., Kearney, N. J., short addresses were given by *Frank Clarke*, Hanson-Van Winkle-Munning Co., Springfield, Mass.; *Rudy Hazucha*, Clinton Co., Chicago; *Wilfred S. McKeon*, Sulphur Products Co., Greensburg, Pa.; *Bill Schneider*, Electroplating Division, E. I. duPont de Nemours & Co., New York City; *Dave X. Clarin*, Oakite Products, Inc., New York City.

A financial report was rendered by *Thomas A. Trumbour*, Permanent Secretary, after which election of officers was held with *Jack F. Geissman* of Maas & Waldstein Co., Milwaukee, Wisc., being elected Chairman, and *A. Fred Norgren*, Frederic B. Stevens, Inc., New Haven, Conn., elected as Vice-Chairman.

A. Fred Norgren

A Resume of the Papers Delivered at the 27th Annual Convention of the American Electroplaters' Society, Asbury Park June 19,20,21,22, 1939

Condensed by Joseph B. Kushner, Ch.E.

1. Notes on the Adhesion of Electroplated Coatings

A. W. Hothersall, M.Sc.

This paper, is primarily concerned with the adhesion of electroplated nickel on steel.

Why do electrodeposits adhere so strongly to the basis metal? The force that holds them together can no longer be considered as being due to "anchorage" effects though it may in part be responsible. The forces of adhesion, because they are so great in many cases, must be atomic in nature. The enormous pull (28.1 tons/-sq. in.) required to tear away a nickel deposit from a mild steel basis metal cannot be explained by any other mechanism. A further proof of this possibility is the classic work of Blum, Rawdon and Graham on the continuation of copper crystal structure by the deposition of copper upon copper. Similarly it can be shown that nickel continues the microstructure of an annealed iron base by removing the specimen from the nickel bath after a few minutes and continuing the deposition in an acid copper bath. Photomicrographs indicate that the copper continues the nickel structure and shows close resemblance in structure to that of the iron.

However, nickel deposits sometimes adhere very poorly to iron. Provided that the surface of the iron is absolutely clean and free from films, this non-adhesion is due primarily to the weakened condition of the iron because of mechanical treatment such as machining, rolling, etc. To obtain good adhesion, the surface layers of the steel must be first removed by etching. Anodic etching in concentrated sulphuric acid (75%) is suitable for this purpose and is used extensively in England. More dilute solutions of sulphuric (30%) are sometimes used where more vigorous etching is required such as in the building up of worn machine parts. The 30% solution is sensitive to temperature, which must be kept below 25°C. If it goes above this temperature, it will dissolve the steel with 100 percent efficiency leaving a residue of carbides (commonly known as "carbon smut") on the surface of the steel. Pictures and charts, illustrating adhesion tests of nickel on steel and the adhesive forces between nickel and various basis metals are given. The force of adhesion between nickel and steel is greatest, between nickel and aluminum, lowest.

Distribution of Deposits on Cup Shaped Articles

C. E. Gardam, B.Sc.,A.R.C.Sc.

The results of a series of experiments on the distribution of deposits on a hemispherical bowl are given.

It is not difficult by controlling time of deposition and current density to get a deposit of a given average thickness but some parts of the plate will be of less than average thickness. Just how much less is not determinable generally but can be determined in specific instances as is done for the particular case of a hemi-spherical bowl.

There are three ways of altering the distribution of electroplated coatings: 1. Select solution of good throwing power. 2. Select best operating conditions. 3. Arrange anodes, etc. to get the best effect. For purposes of experiment the cups were plated under standard conditions, in the center of a cubical tank 10″x10″x10″, of 4 gallon capacity. Only one cup was plated at a time in the center of the tank. Thicknesses were measured by the B.N.F. jet test. The ratio of the thickness of deposit inside the zenith (point furthest from the mouth) of the cup and outside is a measure of the throwing power. Without throwing power, the ratio can be calculated. It is 15. Anything less than this indicates some throwing power but distribution is not good unless the ratio is smaller than 3.

With a simple matte nickel solution the ratio was 8. Sulphonated bright nickels gave about the same result. Cobalt bright nickels gave much poorer distribution with ratios of about 24 and 15. Chromium was very poor with a ratio of 27. Acid copper 11, cyanide copper 1.6. Bright tin and bright cadmium from Bradshaw's and Hothersall's baths gave ratios of 2.6 and 3.5 respectively. Changing the position of cup or

anodes had little effect. In a smaller tank, distribution was worse. In a big tank, distribution was a little better. Plating the cup in the presence of six others resulted in material change in distribution of deposits but the ratio remained practically the same as for the cup when plated alone, namely, 7. Conclusion is that the average thickness in nickel plating must be 4 times the minimum allowed. Illustrated.

Recent Developments in British Plating Practice

C. F. Francis Carter, Ch.E.

A resume of the latest developments in plating practice in England.

The largest new development is the growth in the use of bright nickel. Rochelle salt copper and bright zinc have now been adopted. The bright nickels most frequently used are Weisberg's cobalt-nickel and Hinrichsen's cobalt-nickel. Hinrichsen's solution contains no formaldehyde. Plating on steel lags behind mainly due to poor surface finish of the British product as compared to American sheet steel. Standard practices for bright nickel, zinc, etc. are given. Chromium is being used in aircraft work. The use of rubber lined tanks is expanding. Rubber covered coils have been tried for heating with only partial success. Ebonite coils are now being used. There is some use of circulatory heating of tanks; heating contents of plating tank as they are filtered, by passing the electrolyte in coils through a heater tank. There is a definite trend towards specification plating. The common method for thickness testing is the B.N.F. jet test. The British Standards Institute has appointed committees to standardize: 1. Colors, 2. Deposit Specifications.

Chemical Methods for Testing Thickness of Metallic Coatings

S. G. Clarke, Ph.D.

A description of the processes for measuring plate thickness now in common use in England.

The method of microsections has been known for a long time but only few concerns can afford the apparatus. It is also too laborious to use. There are only two kinds of practical methods for measuring thickness. The dropping and jet tests and the magnetic methods. The B.N.F. jet test gets its name from the British Non-Ferrous Metals Research Association. The principle of the method is simple. A trickle of liquid suitable to the purpose is permitted to impinge upon the deposit dissolving it in a given area until the basis metal is exposed. An indicator is present in the solution to give the end-point (to visually demonstrate exposure of the basis metal). The process spoils the coating but does not destroy the basis metal which can be stripped and used over again. Most important point is that the liquid must be delivered at a definite, constant speed. Illustrations show apparatus used.

Review of Electroplating Methods in France

M. Ballay, Ph.D.

A resume of French Electroplating Practice.

There are approximately 900 plating shops in France. Most of these are very small making it impractical to install modern equipment. Trichlorethylene and alkali electrocleaning are in common use. Steel is generally etched with 75% sulphuric acid prior to plating. Rochelle salt copper baths are in fairly common use. Most nickel plating solutions are of the Watts type. Nickel is deposited on aluminum by the ferric chloride etch method. Depolarized nickel anodes are used. In chromium plating a ratio of 1 to 100 is maintained between sulphate and chromic acid; lead-antimony anodes are used. Electrolytic zinc plating is very rarely employed. There are few automatic plating installations. In large installations the plater rides on a trolley adjacent to the tanks thus saving much energy and time. The very rough, spot tests are used for thickness determinations. The French Committee on Standards has appointed a commission to standardize 7 classes of nickel plating. There has not been much opportunity for academic instruction in electroplating. In general, French practice is to some extent similar to ours.

Chromium Plating Wire

Dr. A. Guerillot, Electrochemical Engineer

Description of a French Plant that chromium plates fine wire used for officer's braids.

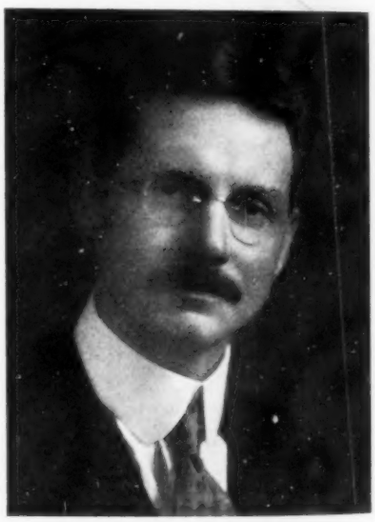
Diagrams and illustrations show the apparatus, which is completely automatic. A reservoir tank feeds fresh chromium solution to the plating bath at required intervals. Solution contains 300 grams of chromic acid per liter with 1½ grams of potassium fluoride for every 100 grams of chromic acid. Current density is 160 amperes per sq. ft. This amounts to about 90 milli-amps. per ft. length of wire in the bath. The deposit is very bright with good adhesion. When larger production is desired, 6 such tanks are used in parallel or the course of wire in one tank is made zig-zag.

The Role of Diffusion in Electroplating Processes

Dr. J. T. Burt Gerrans

A theoretical approach to diffusion in electrodeposition.

The fundamental equation of diffusion is $\frac{dz}{ds} = \frac{K}{} \frac{dc}{dx} \cdot t$. Due to a difference of concentration set up in a cell when current begins to flow, convection currents are induced, flowing



Dr. J. T. Burt-Gerrans

down from the anode and up to the cathode. No matter how strong the agitation, the layers adjacent to the electrodes caused by these convection currents are always present. Electrolytic migration is an additional force to be considered. Temperature also affects diffusion, altering the viscosity of the solution. The transport number of given ions can be changed by adding conducting salts. An electrolyte may be regarded as an infinite number of conductors in parallel. Edges and points receive most current and are thus most prone to "burn-

ing." Potentials are responsible for throwing power. Concentration potentials are also introduced once the cell is set up. Illustrations and oscillographic curve for copper deposition are given.

Theoretical Training for the Electroplating Industry

Dr. J. T. MacEwan

A discussion of what educational background is needed for those in the plating field.

A good basic knowledge of mathematics, physics and chemistry, such as is given at recognized engineering schools is a prerequisite in the plating field. Every plating shop should employ either directly or indirectly a man who has this fundamental training. Such a man can install new processes and study new developments to the benefit of the proprietors. Extension courses in metallurgy and electrochemistry are given by many universities. Good libraries must be

Burton G. Daw

made available. Instruction in library research is needed. The design of instruction laboratories must be well considered. Educational committees can offer course of instruction in the subjects required.

Electrodeposition of Black Molybdenum Finishes

R. A. Hoffman and R. O. Hull

Description of a new type of black deposit.

Most black deposits are unsatisfactory. Black nickel is too sensitive to changes in bath composition and conditions, giving too many variations in color. Good deposits of an extremely deep and lustrous black are obtained from a bath containing ammonium molybdate, nickel sulphate and boric acid. The bath has a high rate of deposition, high throwing power. The rate of deposition is 0.001" in 10 minutes. It deposits over cadmium and zinc die castings. The most lustrous deposits are obtained at higher temperatures. The pH is kept between 4.3 and 5. Above 5, the deposit becomes brittle; below 4.3, streaked and irregular. Work rod agitation is recommended. Plates directly over aluminum cleaned only in an alkaline cleaner. Can only be used with insoluble anodes. The rate of deposition seemingly varies inversely with current density. Special stabilizing agents are required. Illustrated with graphs.

The Ampere Hour Meter

Burton G. Daw

The application of the ampere hour meter to plating.

The ampere hour meter is and can be a very useful adjunct in plating. It may be used to eliminate, or at least partially eliminate, chemical control of plating solutions. Starting with a fresh solution and an ampere hour meter, by experimentation and trial in the beginning, one can learn for example that after a given number of ampere hours have passed through the tank, the pH will have dropped a definite amount and an addition of a certain quantity of acid or base is required in order to return the solution to its normal pH. The number of ampere hours passed can also be used for determining the proper time for other replenishing additions to the tank, and if drag-out and other losses are correlated with it, can be used for providing a formula for computing cost of operation.

Current Density Range Characteristics: Their Determination and Application

R. O. Hull

Description of a test plating cell for determining current density ranges best suited for deposition.

A test plating cell holding approximately 1 quart of electrolyte, of rectangular dimensions, in which one electrode is parallel and contiguous with a wall face, the other inclined at an angle to it, is capable of giving information regarding suitable current densities in plating solutions. The near end of the inclined cathode receives a large current, the far end, less current. Intermediate between these points there is a continuous gradation of current. Using various plating solutions and steel or copper cathodes, it is possible to determine their bright ranges by inspection of the cathode for the brightest deposit. At this point the current density can be calculated, or estimated by the application of the formula $A = C\ (18.8 - 28.3 \log L)$, where A is current density at the point C the overall current density, and L the distance of the point from the cathode. This is useful for controlling solutions etc. Illustrated with charts and graphs.

Chromium Plating Dies and Gauges

D. A. Cotton, E.E.

Outline of the rebuilding of worn machine parts with chromium, at the Delco Remy Plant.

D. A. Cotton, E. E.

The rise in the use of chromium for building up worn and used machine parts is becoming more and more important. The value of chrome lies in its resistance to wear and exceptional smoothness. Its use saves a great deal of time and cost. The method was first used on small tools in a 2 gallon tank, is now used with a 50 gallon tank and two, 2 gallon tanks, saving as much as $16,000 yearly. Steel dies lasting ordinarily only 15 hours in use last longer when chrome plated. Other examples illustrate hardness and long wear of chromium plated

parts over nickel plated or plain steel. The ratio of chromic acid to sulphate in the bath used is 73 : 1. The standard procedure at Delco Remy for this class of work is outlined in great detail. Parts and pieces processed are illustrated.

Anodic Coating of Aluminum

Dr. Junius D. Edwards

A resume of anodic coating of aluminum with particular reference to the "Alumilite" process.

Historically, anodic coatings produced by treatment with chromic acid were used first. Oxalic acid is also used. The sulphuric acid process ("alumilite" process) is now most frequently used. The oxide produced by this latter method is uniform in thickness. Fairly heavy coatings can be built up. Alloys with much copper in them are poor subjects for anodizing. The bath is easily controlled and efficiency is 100%. The property of absorption is possessed by the oxide enabling it to take up colored matter such as pigments and dyes. Dyes in the oxide layer fade on exposure to sunlight but inorganic pigments resist fading. Porosity is sometimes a defect as it permits the absorption and retention of dirt, etc. Defect is overcome by sealing pores after anodizing with treatment in hot water or by use of waxes and oils. The coating is abrasive in nature; a relative of natural emery. It cracks when the basis metal is bent but does not peel. The oxide coating has unique transmission and reflection properties for light waves. At 10 mu it reflects very little and acts as a black body. Heating puts stresses on the coating because of the low coefficient of expansion as compared to the basis metal. The oxide coating is not recommended under these conditions. They withstand the weather and offer excellent protection. Illustrated with charts.

The Application of X-Ray Diffraction to Electroplating Problems

Herbert R. Isenburger

A correlated abstract of the application of X-rays to electrodeposition.

X-rays can be utilized in many ways by electrodepositors. They can be used to show grain structure beyond the resolutions permitted by the use of a microscope. They can be used for measuring crystal size, for determining grain orientation, lattice distortion, allotropic modifications, etc. The sharpness of the rings indicate crystal size. On polished metals these are very diffuse indicating fine grain size. X-rays may also be used to determine the thickness of coatings if the basis metal is of a different system, provided a check sample is used. Illustrated with X-ray diffraction pictures.

Herbert Isenburger

Bright Dips for Non-ferrous Metals

Dr. Walter R. Meyer

A description of various bright dips for non-ferrous metals.

Bright dips are used for various reasons: To provide a usable finish; to remove slag, oxides and rust; preparatory to plating; in the polish- of metals. A good bright dip should primarily give a metallurgical contrast etch as this is the essence of the brightness produced. It must attack the basis metal uniformly and leave no salts on the metal when withdrawn. It should not cause excessive fuming, and should be fairly rapid in its attack. Most bright dips are oxidizing in nature. Bright dips for aluminum, zinc, cadmium and copper are described in detail. Anodic polishing, a subject introduced by Jacquet is attracting more and more attention. Copper smoothed down with emery can be polished anodically in ortho-phosphoric acid at a current density of 60-100 amps per sq. ft. Surfaces so produced have higher reflectivity than wheel buffed surfaces. Illustrated.

Dr. Harold J. Read

A Study of Nickel Anode Corrosion and Loose Nickel Phenomena

T. P. McFarlane

A preliminary report on research being performed at the University of Cincinnati.

Dr. A. Kenneth Graham

Nickel anodes corroding unevenly, cause fragmentation. These fragments and particles of nickel and impurities, in turn, cause bad plates. The effect of current density on the corrosion of nickel anodes of different types was noted. Cast and rolled anodes of various types were subjected to increasing current densities. The anodes were bagged and the fragments collected magnetically. The backs of the anodes were rougher than the fronts. The size of the particles varied with the current. There were smaller particles at higher current densities. The curve of variation of percent of loose nickel against current density shows a minimum around 35 amps per sq. ft.

A Study of Electrolyte Films

Dr. A. K. Graham, Dr. H. Read and Associates

Research on cathodic films.

Reactions controlling the structure of the deposit occur in the film adjacent to the cathode. No research has been done to date on the subject. The writers have devised a special apparatus for sampling the cathode film or the film adjacent to the cathode, for the purpose of analysis. With the plating cell in a water bath, samples are drawn from the cathode through a capillary tube by means of natural syphoning action. The pH of the sampled film was measured with quinhydrone electrode. It was analyzed for nickel with a special method to insure accurate results. The results of these analyses are plotted in a series of graphs and curves. These seem to indicate our ideas of cathode films have to be revised and we must seek a new explanation for burned deposits to replace the one based on the idea that the high pH of the cathode film at large current densities induces precipitation of basic material on the cathode. The method can be further improved, and further experiments are to be made.

The Story of Steel for Electroplating

Frederick Fulforth

A motion picture.

A movie illustrating all phases in the manufacture and fabrication of steel strip for electroplating purposes. The raw ribbon steel is taken through the various pickling, annealing, rolling, slitting, etc. operations until it is ready to be delivered, mirror bright to the manufacturer of electroplated articles.

The Modern Generator and Rectifier

Guerin Todd

Discussion of the modern generator and rectifier.

The first generator was made in 1844 for electrodeposition. Weston made the first improved generator in 1871. The compound generator was introduced in 1900 and interpoles at about the same time. Metal graphite brushes were brought into use in 1920. Generators have high efficiency. Copper graphite brushes are affected by absolute humidity. With controlled humidity generator loads can be increased 25%. Generators have fairly good voltage regulation. At full load, copper oxide rectifiers are more efficient than generators. Copper oxide rectifiers age, but after 1000 hours of use the effect is no longer apparent. Where only voltages such as 3 and 4 are used, rectifiers supplying only these voltages should be employed for greater efficiency.

Time Pieces from Sundials to Wristwatches

L. A. Critchfield

A history of horology and watchmaking.

The story of time from the star observations of the early Babylonian priests to present day modern watches is given profusely illustrated with samples and specimens.

Complex Cations as the Important Influence in Electrodeposition

Prof. F. C. Mathers

General research on the effect of addition agents to baths.

The effect of the composition of a plating bath on the character of the deposits is well known. Addition agents alter bath composition and may form complex cations with the ingredients in the bath thus producing bright smooth deposits. Solutions are very complex. Supposedly neutral salts have effects. Water has several varying compositions and ordinary water consists of 20% H_2O. 59% $(H_2O)_2$, 21% $(H_2O)_3$. HCl affects water by changing these percentages. Even in such simple solutions as acid copper baths, complex cations are formed. The properties of certain solutions can only be explained by assuming different degrees of hydration. Boric and hydrochloric acids form complexes. Aging of plating baths is another example of the formation of complexes. Halides are often found in deposits, indication of the fact that the chlorine, bromine, iodine or fluorine must have been present in a complex cation otherwise it would not have deposited, as the halogens by themselves travel to the anode. Experimentally, deposits of lead, antimony and tin were made. Halides added in small amounts gave increasingly poor deposits, the effect becoming stronger in the order Cl, Br, I. Silver nitrate with iron nitrate and tartaric acid gave good smooth deposits of silver. "Each metal is a law unto itself." No one addition agent will work with every metal. This tends to prove that these addition agents probably form complex cations with the metals involved. Good deposits have been obtained from lead sulphamate baths. Illustrated.

A Review of Finishing Methods

Gustave Klinkenstein

A review of all known methods of lacquer and synthetic finishing of metals.

Dr. Gustave Klinkenstein

Work can be finished by: Brushing, roller coating, tumbling, manual and mechanical dipping, centrifuging, gasket coating, hand and mechanical spraying. The field of use for each type of coating is outlined. Hand spraying is most frequently used. Latest developments are circulatory paint systems and hot lacquer spraying.

Agitation

Donald Wood

A discussion of the subject.

If any motion of the solution is considered agitation then no still solutions exist, as convection currents and gassing at the cathode bring about agitation of the solution. Temperature and agitation control the film thickness. Agitation is different on different parts of the cathode, which produces different degrees of polarization. Agitation permits higher current densities to be used. Illustrated with diagrams.

Adhesion of Electrodeposits

F. C. Mesle

Description of a new method for testing adhesion.

Electrodeposits should have specifications for adhesion as well as thickness. Adhesion was tested by soldering a lug to the surface and pulling it off, but heating almost always improves adhesion so the method cannot give relatively accu-

Frank C. Mesle

rate results. A gadget working against a coiled spring, somewhat in the manner of a sardine can opener is used to test deposits. One section that has been purposely non-adherently deposited is fitted into a slot and the key is twisted. The number of notches turned through before the specimen snaps, is a measure of the adhesion of the deposit. Numerous samples and tests are given.

Practical Suggestions for Efficient Plating Layout

D. R. Hartshorn, Jr.

Discussion of plating room lay-outs.

Plating plant lay-out should be so designed as to obtain the most efficient usage of space provided. Several different types of arrangements should be tried on paper before deciding on the final one. Space can be conserved by use of modern high speed equipment. A light, airy room is essential. The walls should be of brick or tile, laid with cement or mortar. Sewers are very important. Drainage trenches should be properly sloped and spaced. Neutralizing tanks must be provided in many cases; state and city ordinances should be consulted first. The best type of floor is probably concrete correctly sloped at an angle not less than 1/8" per foot. If duckboards are used they should be made of hardwood. Wherever possible, the plating room should be separated into compartments. Lighting must be adequate, especially lighting for cleaning, plating and inspection stations. Many plants do not provide proper ventilation. Entering air must be considered. For most cases 6-10 changes of air per hour will be sufficient. Generator losses can be reduced by improving the distribution of current. The relative advantages and disadvantages of automatic, semi-automatic and manual plating tanks should be considered. Illustrations and diagrams of contemporary lay-outs are given.

The Effect of Certain Wetting Agents on Nickel Deposits

Dr. C. B. F. Young

Experimental.

In general, wetting agents lower the surface tension of solutions. In all probability they act as both wetting agents and addition agents. The surface tension of water is about 70 dynes per cm. The standard nickel solution used (simple matte nickel) had a surface tension of 79 dynes per cm. Use of wetting agents brought this value down considerably. All wetting agents are given by their trade names. At high pH, solutions containing wetting agents tend to be murky, at low pH, clear. A change in the structure of the deposits was noted whenever a wetting agent was used. Running two baths in series, one containing a standard solution and the other standard with a wetting agent, it was discovered that the standard nickel deposit showed striations whereas the other did not. There seems to be evidence that the crystalline structure is decreased in size by the use of wetting agents. Illustrated.

Summary of Activities on Electrodeposition at the National Bureau of Standards

Dr. William Blum

Resume of Bureau activities on the subject.

Magnetic instruments for thickness measuring are calibrated and tested at the Bureau. Brenner has done considerable research on alloy deposition. He has studied the copper-bismuth system, depositing them from perchloric acid, to determine fundamental facts. Discussed the engraved plates on exhibition; how they were made.

Porosity Tests for Nickel Coatings on Steel

P. W. C. Strausser

A resume of test results.

The effect of forming operations was studied. Test used was the ferroxyl test, using a solution of sodium chloride and sodium or potassium ferricyanide. Excess ferricyanide attacks the nickel deposit and as a result, a modified form of the ferroxyl test was developed. No ferricyanide is present in the paper applied to the steel. The paper is gelatinized then impregnated with salt solution. It is placed on the nickel plate for ten minutes then developed in a ferricyanide bath. This is called the "development" method. Hot water tests seem to show less

Dr. William Blum

porosity than the "development" method. Alkali in the glass containing vessel, may dissolve upon prolonged heating (6 hours) and seal some of the pores. The salt spray method is not very satisfactory for counting pores. The use of iodine solution may be of interest. It shows up not only the pores but also basic inclusions in the plate. Results of these tests compared with atmospheric tests indicate that 0.001" of nickel is practically pore free and furnishes a good protective coating.

(*Continued on page* 332)

The Measurement and Control of pH

By Nathaniel Hall and G. B. Hogaboom Jr.

This is the concluding part of the article which was published in the June issue. Colorimetric methods for determining pH as well as pH papers are discussed.—Ed.

For industrial application, the antimony electrode is most suitable because of its ruggedness, consisting as it does only of a mounted block of antimony metal immersed in the solution to be tested. It is not as accurate as the other electrodes and cannot be used in low pH solutions, but is satisfactory between the ranges of 4 to 11.5 pH with an accuracy of ± 0.2 pH. This range can be extended from 2 to 12 pH under special conditions although about 11.5 it may take an hour for equilibrium to be established. It cannot be used in strongly oxidizing or reducing solutions and has an appreciable error in the presence of traces of copper or silver salts and large concentrations of sodium salts. The antimony electrode is often used in open tanks and pipe lines for the continuous measurement of pH since it does not require the addition of any reagent, solid, liquid or gas nor does it contaminate the solution.

None of the above-mentioned electrodes can be used with oxidizing or reducing solutions or solutions which are unbuffered. Hughes, in 1922, showed that a glass electrode could be used in the same manner as the other electrodes and was independent of the presence of oxidizing or reducing agents. One form of this electrode consists of a very thin glass membrane on the end of a glass tube. In the tube is placed a quinhydrone electrode in hydrochloric acid solution having a pH of 1.0 or a silver-silver chloride electrode in a buffered chloride solution. It is not suitable for solutions above 9.6 pH containing sodium ions in concentrations greater than about 0.3 oz./gal. Unless calibrated for a given concentration, in which case, the readings can be made to within 0.15 pH units. In other solutions, it may be used from pH 1 to 12 with a limit of error of 0.1 pH when properly calibrated.

Due to the very high resistance of the glass membrane, usually 2 to 6 million ohms and even higher, a very highly sensitive galvanometer, or for less accurate control work, a means of amplification must be used to measure the current flow. This necessitates more expensive equipment and introduces a source of error due to the slight conductivity of the moisture film on the parts of the assembly especially in damp weather. On the whole, however, the glass electrode is usually the most suitable for general operation in spite of its fragility and other faults. It gives more accurate results than any other pH electrode with solutions which are only slightly buffered and requires no additions of auxiliary material to the solution.

In measuring the pH electrometrically, the calomel reference electrode together with one of the indicating electrodes are immersed in the solution and the potential is measured by impressing an opposing potential which is varied until a galvanometer in series shows no deflection. This indicates that the opposing potentials are equal and no current is flowing. The impressed voltage is then measured with a millivoltmeter or a calibrated resistance and a standard cell. For any system of electrodes, the pH is a function of the voltage and can be read from tables or directly from the dial or meter of the instrument if it has been graduated for use with a certain electrode system. This potential balancing or "Null Point" method as it is known insures that no appreciable current flows through the test solution, thus removing the possibility of electrode polarization affecting the potential reading.

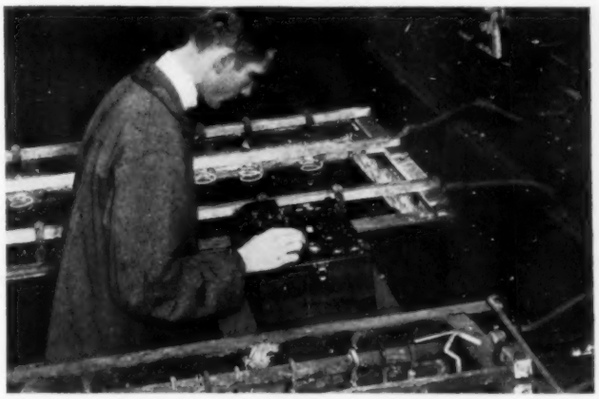


Fig. VI. Measuring the pH of a plating solution with potentiometer. (Courtesy Leeds & Northrup Co., Philadelphia, Pa.).

For the low resistance electrodes, the current flowing, although too small to affect the electrodes, is sufficient to cause a movement in the galvanometer, which is an ammeter sensitive to a few billionths of an ampere. The resistance of the glass electrode is so high, however, that the current which flows with the potential available is too small to give results with the ordinary galvanometer and one of extremely high sensitivity must be used. For a permanent, non-portable installation, this arrangement is satisfactory and highly accurate, but in a portable instrument it is usually found more practical to amplify the small current by means of a thermionic or vacuum tube amplifier

such as is used in radio work so that the readings can be made with a less sensitive but portable galvanometer. The amplifier usually works on the 110 volt line or batteries, and although not as accurate as the high sensitivity galvanometer, is satisfactory for control work where an error of 0.02 units is of no importance.

Electrometric pH devices are employed where the solutions to be tested are highly colored, or of an oxidizing or reducing nature or where highly accurate results are desired. One of the most important applications in present day industry, however, is in the automatic recording of acidity and the automatic maintenance of the pH at any predetermined figure. In the case of the other methods for measuring pH, this is not practicable at present but with the use of an electrometric device, the small amount of current that passes during operation may be amplified sufficiently to operate a recording pen or to actuate a relay which controls a feed valve for the addition of acid or alkali. The electrode unit consisting of a calomel reference electrode, a glass or antimony measuring electrode and a temperature compensating bulb, is immersed in a tank and is protected from breakage by a wire cage of suitable material. The unit is also used in an enclosed flow type assembly, as shown in the figure, through which the solution to be measured is pumped. Leads extend from the electrode assembly to the recording or controlling potentiometer which is mounted in a convenient location.

Colorimetric Measurement

The colorimetric methods for pH determination are preferred wherever possible because of the much lower cost of equipment and the simplicity of operation. The liquid standards are guaranteed against change for 5 years by the manufacturers. In operation two or three tubes are filled with the solution to be tested, ½ cc. of indicator is added to the center tube and the color matched against the standards. The tubes are rinsed with water and are ready for the next test. There is no maintenance of electrode and batteries and a minimum of space is required. It takes much less time to test the pH colorimetrically.

There are certain disadvantages in connection with the use of the colorimetric method. Since the tubes are furnished with intervals of 0.2 units the results can only be determined to within 0.1 pH, while the electrometric methods may be accurate to within 0.002 pH. For control work this is not very important. If the solution being tested is highly colored or contains colloidal matter as for example some bright nickel solutions, the method is not satisfactory. If the solution is not highly colored, the matching is not affected appreciably because a tube of the solution is placed before each color standard and a tube of distilled water is placed behind the test solution so that we get the same depth of solution in each case. This depth of solution is of importance since some indicators such as bromcresol purple and bromphenol blue have distinctly different colors when viewed through different thicknesses, a phenomenon called dichromatism. In turbid solutions, the use of indicators involves great errors and the electrometric method or pH paper must be used. If the solution contains an oxidizing agent such as chromic acid in an anodizing bath or reducing agents such as are present in industrial liquors, the indicator is affected. The method is also subject to salt errors. For example, in a nickel solution the reading is usually 0.4 to 0.6 units higher than the electrometric reading.

Fig. VII. Comparator with permanent glass discs for determining pH. (Courtesy Hellige, Inc., L. I. City, N. Y.).

Fig. VIII. Comparator with sealed liquid standards for determining pH. (Courtesy Kocour Co., Chicago, Ill.).

Proteins, colloids and amphoteric hydroxides such as aluminum or zinc hydroxide tend to absorb certain indicators and affect the color. Since the indicator dissociates either as an acid or a base and affects the hydrogen ion concentration, an error is introduced which is very appreciable in solutions which are only slightly buffered and which varies with the different indicators. It is not uncommon to find two indicators whose ranges overlap, giving readings as much as 0.5 units apart. This is most often apparent at higher pH values, especially when the salt content is high.

The liquid color standard tubes are prepared by adding ½ cc. of indicator to 10 cc. of a buffered solution of the desired pH which has been determined electrochemically. The tubes or ampoules are sealed and will last for years if kept in a cool, dark place when not in use. The non-fading glass standards are made of tinted glass which when viewed by transmitted light has the same color as the liquid standard of the same pH. In nickel plating solutions, it is often more difficult to get a good color comparison with the glass standards than with the liquid tubes but the former is small enough to be carried around in the pocket and there is very little possibility of breakage of the standard colors

so that there may be advantages in some cases which tend to balance the higher cost of the set.

Colorimetric standards are usually furnished with intervals of 0.2 pH for ranges of 0.2 to 13.6 inclusive. Indicators are dyes which change color in passing from an acid to an alkaline condition or vice versa. There are a large number of such dyes but only few have all the required characteristics of a good indicator, which include a definite change over a pH range, rapid color formation, no precipitation and inertness to other than hydrogen and hydroxyl ions. The most commonly used indicators are as follows:

Indicator	pH Range	Indicator	pH Range
Acid Cresol Red	0.2-1.8	Oleo Red (LaMotte)	8.6-10.2
Metacresol Purple	1.2-2.8	Phenolphthalein	8.6-10.2
LaMotte Yellow	2.6-4.2	Phthalein Red	8.6-10.2
Hellige Orange	2.6-4.2	Thymolphthalein	9.4-10.6
Bromphenol Blue	3.0-4.6	LaMotte Purple	9.6-11.2
Bromcresol Green	4.0-5.6	Hellige Alkali	10.4-12.0
Methyl Red	4.4-6.0	Tolyl Red	10.0-11.6
Bromcresol Purple	5.2-6.8	Sulfo Orange	11.0-12.6
Chlorphenol Red	5.2-6.8	Parazo Orange	11.0-12.6
Bromthymol Blue	6.0-7.6	Tropaeolin O	11.2-12.8
Phenol Red	6.8-8.4	LaMotte Violet	12.0-13.6
Cresol Red	7.2-8.8	Hellige Violet	12.0-13.6
Metacresol Purple	7.6-9.2	Acyl Blue	12.0-13.6
Thymol Blue	8.0-9.6		

In the highly alkaline solutions, there is a tendency to bleach or discolor the indicators so that the colors can be compared only with great difficulty if at all. In such cases, it is the usual practice where extreme accuracy is not required, to dilute the test solution with an equal part of water and even more in highly buffered solutions such as are encountered in plating baths. Due to the buffering action, the pH does not change very much upon dilution and satisfactory results are obtained. This phenomenon can be more readily understood if we consider that a large change in volume or concentration is equivalent to but a small change in pH. A decrease in hydrogen ion concentration to 1/10 the former value as from 0.01 (10^{-2}) to 0.001 (10^{-3}) for example changes the pH by one unit only.

pH Paper

A modification of the colorimetric method that has been developed recently employs strips of paper impregnated with the indicator and a series of colors. When the strip is immersed in the solution to be tested the indicator changes color. By comparing the color with the standard color bars, the pH can be determined. This method has certain advantages over the glass or liquid standard comparators. There is no glassware to break and the paper can be carried around in the pocket. Tests are made quickly and easily at the tank without the necessity of withdrawing samples of the solution. The initial investment is lower than for the glass or liquid color comparators. However, while the cost of one test using indicator solution will be about ½ cent, in the case of the paper strips each test will cost from 2-¼ to 3 cents. Colors are more readily matched with the glass or liquid standards because they are viewed by transmitted light but in control work where the pH of the solution is not critical, the strips are very satisfactory. The pH papers should be compared as soon as possible after removal from the solution since the color fades on standing due to evaporation.

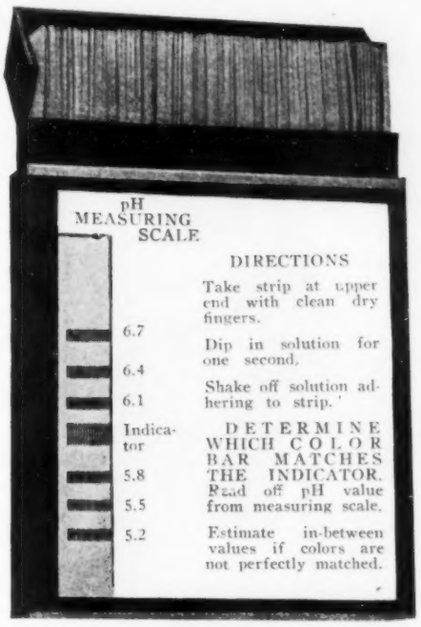


Fig. IX. Papers for determining pH of plating solutions. (Courtesy Paul Frank, N. Y. City.)

Application

The metal finishing industry finds applications for all the above-mentioned devices for pH control. In very small plating rooms where only one or two solutions such as nickel, acid zinc, etc., require a pH determination only occasionally, pH papers are usually most convenient since they do not deteriorate rapidly. In plants where the pH is checked often or where there are a number of similar solutions, the color comparators using indicator solutions, and liquid or colored glass standards are more economical. In the anodizing of aluminum for coloring, the dyes which are maintained at a definite pH must be controlled with an electrometric pH apparatus. The quinhydrone set is usually used here. When chromic acid is employed for anodizing the concentration can be determined only with a pH set since varying amounts of chromic acid are combined with dissolved aluminum and are not available for the anodizing. Due to the oxidizing character of the solution, the much more expensive glass electrode must be used.

For those bright nickel solutions which require electrometric pH control because of the opacity or deep color, the quinhydrone set is most economical. In solutions of medium alkalinity we have found the antimony electrode to be very suitable while in highly alkaline solutions the only dependable system is the hydrogen electrode which does not lend itself to control work because of the considerable amount of manipulation involved. Using colorimetric comparators in the high pH ranges, fair results are obtained especially if the solution is diluted.

Measurement of Drag-Out

By Joseph B. Kushner Ch. E.

Joseph B. Kushner

The economic wastes resulting from drag-out have been considered by other authors including Hogaboom, Soderberg, Hall and LoPresti. Mr. Kushner has attempted to reduce the determination of drag-out losses to simple operations so that they can be determined readily by practical men.—Ed.

With the passing years, more and more attention is being focused on the subject of drag-out. The growing trend towards greater metal concentrations in present day plating baths has made it imperative for the electroplating engineer to consider the effect of this undesirable yet unavoidable element on plating performance and cost.

Up to the present time, no direct practicable method has been suggested for determining drag-out under actual production conditions. Studies of the factors correlated with drag-out have been made by Hogaboom[1], Soderberg[2] and Hull[3] but none of these authors has described feasible methods for measuring it in the plating shop. These observers give values for drag-out on standard test pieces with simple surfaces, determined by washing the object on removal from the plating tank with pure water, into a beaker, analyzing the wash solution for metal content, and computing the drag-out on the basis of the known metal content of the plating solution.

While this method is most accurate, especially on a beaker scale, it cannot be considered practicable in the light of the difficulty the plater would encounter in the washing of large and varied pieces with a wash bottle and collecting the run-off. Another drawback to this method is that a measurement on an individual piece under fixed conditions of immersion time, drainage time, suspension angle, etc., may be in great error due to the fact that in production plating these conditions may change, throwing the true value off by as much as 50% from the measured value.

Nixon[4], in a paper to the American Electroplaters' Society (also discussed by Blum and Hogaboom[5]) described an indirect method for determining the drag-out from a given nickel plating tank. The concentration of a salt in the electrolyte that does not decompose, is not removed by electrodeposition or sludge formation, is measured before and after a plating run. Since this salt is removed from the tank only by drag-out, simple calculations give the volume of liquid lost from this source during the period of time taken.

For example, consider a nickel plating bath of 10,000 gallons that holds 2,500 lb. of $MgSO_4$. Suppose that after a 10-day run, the concentration of the $MgSO_4$ has been reduced to 0.23 lb./gal. If the previously mentioned conditions may be assumed, the following computations can be made.

Lb. $MgSO_4$ at start	2500
Lb. $MgSO_4$ at finish	2300
Loss	200 lb.

Average concentration of the $MgSO_4$ during the period

$$= \frac{0.25 + 0.23}{2} = 0.24 \text{ lb./gal.}$$

Therefore, the volume of electrolyte lost, or the drag-out, equals $\frac{200}{0.24} = 833$ gallons; which is equivalent to an every day loss of 83.3 gallons, or 0.83%.

This method of indirectly measuring drag-out, while easy in principle, is hard to apply in practice as the ingredients of a very few modern plating solutions meet the conditions required. Most salts in acid and alkaline plating solutions decompose, form sludges, or are actually plated out to some extent as basic complexes. Thus Blum and Hogaboom[5] cast doubt on Nixon's use of chloride and boric acid for the purpose, by stating, "It is possible in nickel baths that sulphate, chloride and boric acid may enter the sludge, and thus cause an erroneously high value for drag-out." In this connection, it is interesting to note that even the example illustrated above, based on the one given by these authors, might still be invalid if the water of the locality had a perceptible magnesium hardness (drag-in would add Mg ions to the bath at an unaccountable rate). Finally, the method is at best, indirect, and is prone to error as it measures a small quantity by the difference in two large ones.

In view of these facts, the writer proposes a new, direct method for determining drag-out losses under actual plating room conditions. A paper by Kushner[6] on recovery rinse tanks showed that after rinses in a recovery rinse tank used directly after the plating bath, the total amount of metal carried into the rinse tank by the work, is given by the expression,*

(1A) $R = C_o V\ (1\text{-}A^n)$

Where R is the total metal remaining in the rinse tank.
C_o is the concentration of metal in the bath electrolyte,
V, is the volume of the rinse water.
n, is the number of pieces rinsed.
A, is equal to $\frac{V}{V+x}$ Where x, is the average drag-out per rack.

If C is the concentration of metal in the rinse tank after n racks have passed through it, R=CV and we obtain, in terms of concentrations,

(2A) $C = C_o\ (1\text{-}A^n)$

Solving this equation for x, we get

(3A) $x = \frac{V \cdot 2.3}{n} \log \frac{(C_o)}{C_o\text{-}C}$

where 2.3 is the factor for converting $\ln_e$ to $\log_{10}$.

If we consider the drag-out per rack** plated as the volume of electrolyte carried over the edge of the plating tank by the rack, then: (A) this equation holds for automatic plating tanks as the racks on crossing the edge of the plating tank pass directly into a contiguous rinse tank so that there is no liquid lost in transit. (B) this equation does not hold for still tanks where the rinse tank is separated from the plating bath, as there will be an unestimable drip loss in transit. However, if the directions given below are followed the equation can still be made to apply in this case.

To obtain the value of the Drag-Out from Still Tanks. (1). Use as a first rinse, a large crock or tank filled with fresh water, mounted on a mobile base (wooden platform on wheels or casters). Before work is to be removed from the plating bath, draw the rinse tank as close as possible to the point of immersion, so as to eliminate losses in passing from the bath to the rinse. (2) Rinse the rack thoroughly and remove it from the rinse tank at about the same rate it was removed from the plating tank (this keeps the volume of water in the rinse practically constant). (3) After a sufficient number of racks have been rinsed in it, a sample of the rinse water is taken and analyzed for metal content. To get a good all-around value, several such determinations can be made, starting with fresh water in the rinse tank each time. (4) From the value of the metal concentration in the tank, the metal concentration in the rinse, the measured volume of the rinse tank and the number of racks rinsed, compute x, the drag-out per rack, by substituting in (3A).

To Obtain the Value of the Drag-Out From Automatic Tanks

(1) At the start of a plating run begin with a full tank of fresh water in the first rinse after the plating bath. Temporarily shut the inlet and outlet valves if it is a flowing rinse. (2) After a numbered amount of racks have passed through the rinse (sufficient to give an analyzable sample) make a metal analysis of the rinse water and proceed as from step 3 in the previously given directions. Reopen the inlet and outlet valves.

For an example, how the formula is used:

A 10,000-gallon automatic plating tank has a working concentration of 8 oz. of metallic nickel per gallon. The 2000-gallon rinse tank has a metal concentration of 0.04 lb. of nickel per gallon after 40,000 racks have passed through it. What is the drag-out per rack?

$$x = \frac{2{,}000}{40{,}000} \cdot 2.3 \log. \frac{(0.5)}{0.5\text{-}0.04} = 0.004 \text{ gals/rack}$$

The quantity in the parentheses = 1.084, the log of which is 0.03503. Multiplying out gives the answer—0.004 gallons per rack.

Use of the formula (3A), while simple enough, may still be too complicated for the practical man who shys from employing logarithms. However, equation (3) can be further reduced if it is agreed to measure C while it is still very small. If this is the case, $\frac{C}{C_o}$ will be quite small as compared to unity, which gives at once, on solving for x

(4A) $x = \frac{VC}{nC_o}$

Expressing this formula in non-mathematical terms: the volume of drag-out per rack equals the volume of the rinse water, times the concentration of metal in the rinse tank, divided by the number of racks rinsed, divided by the concentration of metal in the plating tank.

Formula (4A) is much easier to use, and for small values of C is almost as accurate as formula (3A). Thus in the case of the automatic plating tank taken as an example, our result would be the same:

$$x = \frac{2{,}000}{40{,}000} \cdot \frac{0.04}{0.5} = 0.004 \text{ gal./rack}$$

It is only when the concentration of metal in the rinse tank has been permitted to build up to relatively high values that (4A) deviates from the correct result.

Many platers, even today, do not make analyses of the metal content of their solution and rely solely on the good old "rule-of-thumb." In such a case, the drag-out can still be computed, by making use of a hydrometer. It will yield only rough results but its accuracy may be sufficient for most purposes.

The reason why this can be done is, $\frac{C}{C_o}$ is a ratio and since the specific gravity of a solution minus unity varies approximately with the total solids content, in a unit volume of the solution, the ratio of these quantities is approximately equivalent to the ratios of the metal concentrations (it is tactily assumed that the proportion of metal to solids is the same in both the plating tank and the rinse tank[8]).

If the specific gravities of the rinse tank and the plating tank are taken, formula (4A) becomes

(5A) $x = \frac{V}{n} \cdot \frac{(S_r\text{-}1)}{S_t\text{-}1}$

where, S_r=Specific gravity of the rinse tank
S_t= " " " plating tank

*The nomenclature used here is slightly different from that employed in the original paper.

**The term "rack", throughout the discussion, is taken to mean the plated work plus the rack on which it is mounted.

In most cases, the specific gravity scale is not used, and readings are taken as Baumé degrees. To use such readings the Baumé readings must be converted to specific gravity by the conversion formula

$$(1B)\quad \text{Sp. Gr.} = \frac{145}{145 - \text{Baume}^\circ}$$

If this is substituted directly into (5A), we get as a final result,

$$(2B)\quad x = \frac{V\ B_t\ (145 - B_c)}{n\ B_t\ \ 145 - B_r}$$

Where B_r is the Baumé reading of the rinse tank; B_t is the Baumé reading of the plating tank.

To check on the value of this rough method for practical purposes, the writer performed the following experiment:

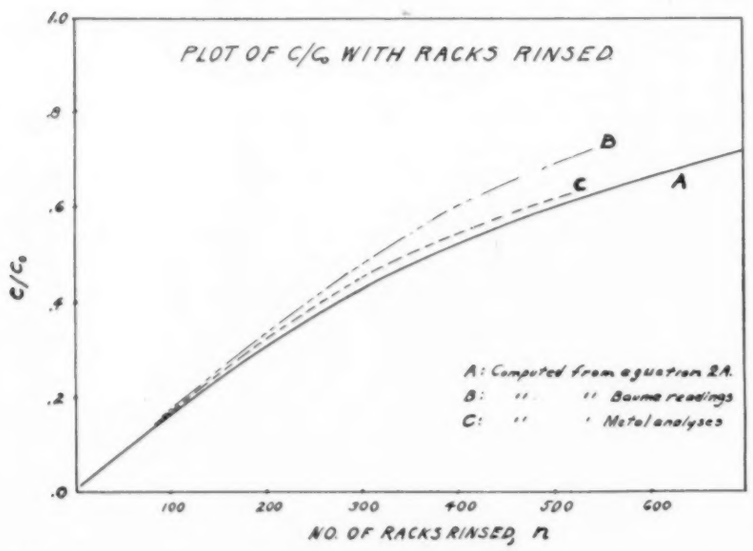
Eight bracelet chains of a type commonly found in novelty jewelry were suspended together on wires as a rack unit. Using a 200-gallon white nickel tank (Baume reading 10.00, total metal content 3.35 oz./gal.) the chains were dipped and removed from the plating tank as in actual plating operation (total time for removal and transfer was, on the average, approximately 2 seconds) and rinsed into a 5.50 gallon rinse crock using the procedure outlined previously. Nickel analyses were made by the standard cyanide method (7). Baumé readings taken with a regular Baumé hydrometer graduated from 0° - 20° Bé. The following data were obtained:

Number of Rinses	Rinse Metal Concentration oz./gal.	Baumé Reading
0	0.00	0.00
60	0.34	1.10
100	0.58	1.80
200	1.08	3.50
300	1.48	5.00
400	1.84	6.00
500	1.98	7.00

Using formula (4A) with the result after 60 rinses, we get

$$x = \frac{5.5}{60} \cdot \frac{0.34}{3.35} = 0.0093 \text{ gal./rack}$$

Using formula (2B) $\frac{5.5}{60} \cdot \frac{1.10}{10} \cdot \frac{135}{143.9} = 0.0094$ gal./rack



The actual value of the drag-out as determined by the method of Hogaboom[8] was 0.0095 gal. under the same conditions of experiment.

In the appended diagram, the ratio $\frac{C}{C_o}$ has been plotted against the number of racks rinsed, as has the $\frac{C}{C^\circ}$ ratio calculated from the Baumé readings, and the theoretical curve computed from equation (2A). These show that the method for measuring drag-out by use of the Baumé readings is sufficiently accurate for rough purposes, while the use of the concentration ratio is even more accurate, especially as the number of rinses increases.

The results obtained here seem to show that the method for determining drag-out, suggested by the writer, is applicable for use by the plater.

To reiterate the advantage of this method for measuring drag-out:

1. It is simple. An analysis for metal ions in the plating tank and the rinse tank for accurate results, or a hydrometer reading of both tanks for rough work are all the difficult measurements required. Easy computations give the result in any units desired, depending on the units chosen for measuring.

2. It is direct. It measures the drag-out *in situ* with an actual determination of the metal lost. Since this is the case, there is no need to worry about decomposition, sludge formation or plate out.

‡In using the hydrometer method, it is important that the rinse tank water and the plating both be at the same temperature when the measurements are made.

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8. See footnote 1.

The curves, continuous as plotted here, should in reality consist of a series of step-like jumps (discontinuities) as with each rinsing there is an increase in concentration for only integral values of n; however, for large values of n this can be disregarded and the curve may be plotted as representative of a continuous function.

Constructive Pre-plating Methods—Part II

By Frederick Fulforth

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This is the concluding installment of Mr. Fulforth's article, the first portion of which appeared in the June issue. Cleaning, pickling and other pre-plating aids are discussed.—Ed.

Cleaning

Practically all metals, as received, require removal of some surface impurities either inherent, as oxide films, carbon or other smuts, etc., or received by contact from drawing compounds, rust preventives, polishing lubricants or just atmospheric dirt or accidental contacts and the expulsion of all of these comes under the first real pre-plating operation known as cleaning.

This is such a wide field that any prolonged discussion here would be out of place, but certain generalities may be drawn in accordance with the original premise of assistance to the plater. It is a fairly well established fact that there is no general purpose cleaner since one of sufficient strength for steel or iron might hopelessly ruin die castings or possibly tarnish even brass.

Another generality may be summarized by stating that since each job sequence is an individual problem, when all other conditions are equal, the cleaner manufacturer best equipped to give service and individual attention in the local field is the logical one for the job.

Again, cleaning costs should be compared on a unit price such as per square foot and not on a per pound basis and actual costs including life, daily additions, rejects directly traceable to cleaning troubles, ease of control and many other records, should be kept and totalled in making an estimate.

Furthermore, even on the same work, one cleaner may not be adequate for all the various elements to be removed. The most recent practice for trouble-free cleaning seems to have come to the following sequence for steel, again taken as an example as being most general:

1. Liquid and vapor degrease.
2. Hand-dust residual dry film when necessary.
3. Electroclean in alkaline cleaner.
4. Warm or cold rinse.
5. Acid dip.
6. Rinse.
7. Optional cyanide copper strike.
8. Warm or cold rinse.
9. Dip in small portion of following plating solution.

In examination of this sequence it must be admitted that many platers are using only a portion of the total with entirely satisfactory results to them, but it is believed, if accurate records were maintained, it might be found cheaper in the long run to install the entire group.

Item by item, they may be explained as follows:

1. The earlier single vapor phase degreasing equipment was exceedingly expensive to operate due to the rapid solvent losses but the modern machine with a boiling dip, cold dip for temperature reduction and final efficiently controlled vapor phase must not be confused with the earlier types, and in fact, one actual case showed an accurate reduction of 18% in overall cleaning cost by the introduction of trichlorethylene degreasing alone.

Wherever mineral oils of any nature occur, it is the most positive method for their removal and has the added advantage of not attacking any metal generally used for plating and since positive removal is essential to good deposition, if this one element can be eliminated, cleaning is far advanced.

It is no cure-all, however, and has no effect on oxide or other films and adherent solid particles.

2. It is for this latter reason that the hand removal or dusting on residual matter is recommended where any appears, although in some cases, the omission of this operation is satisfactory.

3. It is thoroughly realized that for special applications other arrangements such as washing machines eliminate much of this sequence, but for general all-around manufacture some portions of it in the order given are desirable. Soak tanks of strong alkalinity are avoidable by degreasing on new work unless an enormous

amount of dirt, polishing grease or other matter is retained, and in such event it should be eliminated by other methods such as the use of the suggested mineral oil polishing lubricant.

The real purpose of the electrocleaner has been discussed so frequently and the use of anodic, cathodic or a combination of both currents, so controversial, that the matter would be best left for open discussion, except to state that there are now cleaners on the market for which the makers claim the use of reverse or anodic current only, is an essential; which is quite at variance with general practice, as are some of the heavy concentrations up to 12 ounces recommended at present. This latter, of course, gives better conductivity with correspondingly greater gas evolution using more current.

4. Essentially, the alkalinity must be removed from the surface before the succeeding operation if of an acid nature, and this may be done probably better by a warm rinse as any soap content will tend to lose its emulsification in cold water and the fatty acid caused by succeeding acid dips will adhere more tenaciously, although again many platers succeed with the cold water rinse whether by immersion or spray.

5. Acid dips, whether with or without current, are essentially neutralizers or film removers and have a logical place in preparing any surface for plating.

6. The succeeding rinse in neutral water is usually cold as the same conditions do not exist as following the alkaline cleaner.

7. Much has been claimed as advantageous in cyanide copper strikes, but in final analysis, it is generally accepted as a dual cleaning aid—first, by the additional well known cleaning aid of sodium cyanide, and secondly, as an indication of properly performed previous cleaning operations since any foreign matter under the thin cyanide usually shows as a stain on the otherwise bright surface, which is particularly true with the Rochelle salts bath if properly maintained.

Moreover, should peeling of the final coating be encountered, it can be traced to the plate, if stopped at the copper; or to previous operations, if down to the base metal; while the copper may be readily checked in this case by trying some work omitting the strike, and if no peeling occurs, the copper must be liable.

A third benefit may be claimed in that by dropped work no iron is allowed to enter a critical solution, whereas copper can usually be plated therefrom by using a low current density on dummy cathodes.

Its main disadvantages are in the additional maintenance of another solution with its attendant trouble possibilities, as well as unnecessary cost.

Of course, for die castings and similar work its advantages become mandatory under present day knowledge.

8. A repetition of No. 4 entirely eliminated when entering further cyanide solution.

9. Another aid to neutralization and wetting with the final plating solution to obviate misplates due to these two causes, perhaps somewhat over-estimated but again more controversial than essential.

It is certainly true that plating is made or lost by its cleaning methods and today this fact is being considered from all angles.

Miscellaneous Pre-plating Aids

It would be impossible to speak on pre-plating methods without a mention of racks, their manufacture and coatings. No brief is held for any particular kind except insofar as anyone can produce a rack which will withstand trichlorethylene, acid and alkali in concentrations normally used for plating cycles and with heat.

Just to touch briefly on a few additional pre-plating aids, the methods of making up and analyzing new or or old baths may be mentioned. In general, great accuracy is not required and although knowledge of analytical chemistry is an excellent thing to have and should be fostered, nevertheless as pointed out in my paper "Practical Solution Maintenance" (Transactions A.E.S., June 1938), many short cuts may be made when the purchase of complete laboratory equipment is not possible or desirable.

Analytical equipment may be simple to make and use. As an example, consider a cleaner titration outfit:

When making up a new cleaner it is only necessary to take some HCl of any unknown strength, diluted with water to any other unknown strength, and in the presence of a suitable indicator as methyl orange, discover how many cc's on the burette were required to neutralize. Assuming it was 10 cc on a brand new cleaner, by using the same acid and conditions if the reading dropped to 8 cc some time later, it would be evident that somewhere nearly 20% of the total alkalinity in the cleaner was used and knowing the original make-up thereof, a proper addition could be made in correct proportions to return the cleaner to its original strength. This is only cited to illustrate the extreme ease with which maintenance may be accomplished and the practically zero cost required to do it when no laboratory, analytical assistant or other equipment is available.

Again the selection, mounting and usage of generator equipment, including voltage regulators and the meters accompanying them, is a whole problem in itself too frequently overlooked by the plater, as is the material, size and condition of his bus bars.

The real advantage and saving in present day voltage regulators lies in their ability to set for a pre-determined voltage found correct, and when filling the tank from 0 amperes to full load, constant voltage will be maintained irrespective of number, shape and size of pieces introduced into any number of tanks supplied by one generator, thereby eliminating costly hand control while loading, poor contacting and wasteful rheostats with their attendant misplates due to burned edges in first morning loads.

It would be possible to continue along similar lines almost ad infinitum since such matters as plating room floors, ventilation, health hazards, handling, racking, etc., have not even been touched. This is an attempt to instigate an open minded attitude for discussion which will engender further talks and writings along the same lines, about which none of us knows anything when compared to the sum total of possible knowledge, while the only way to increase said total is by a free interchange of ideas and the mutual solution of problems encountered therein.

The Value of the Microscope To the Electroplater—Part II

By Dr. B. Egeberg and N. E. Promisel

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In Part II of this article is discussed the technique of mounting and polishing specimens for microscopic observation. Photomicrographs showing various plating defects are shown.—Ed.

Instead of using an electrodeposited copper backing as a help in polishing, one may use either hot or cold moulded Bakelite to the same advantages. The hot moulding is carried out under a pressure of a few thousand pounds and at a temperature of about 300°F, and for that reason it is limited to electroplates and basis metals which do not alloy with one another at the mentioned temperature. Where it can be used, it is satisfactory and quick in operation (requiring less than 5 min.) and small presses, especially made for the purpose, are on the market at a reasonable price. Instead of Bakelite, one may use the newer type of transparent moulding compositions, which allows one to determine the orientation of the sample within the composite. The authors use Lucite extensively, with excellent results. Where electrolytic etching is required, one may grind or cut down the back side until the sample is exposed, or one may make electrical connection to the sample by means of a copper wire soldered to it before inserting it in the moulding machine.

Tuffs, of the International Tin Research and Development Council, has described a Bakelite moulding which requires much less heat and which, therefore, is applicable where the hot Bakelite mounting cannot be used. It is hard, but not brittle, and adheres well to the specimen, although others have recommended pre-treatment of the specimen with Bakelite varnish. Before mounting, the specimen may be advantageously copper plated to protect the edges, but this is not absolutely necessary. The mounting mixture is made by stirring together 10 c.c. of the acid-hardening solution as supplied by the manufacturer (containing 25% mixed acids) and 100 c.c. of Bakelite resin. This is poured into the mould (e.g. a short brass tube fastened with wax to a glass plate and coated with vaseline) and the specimen inserted. The whole is heated to 105°-115°F for about half an hour, until the resin begins to harden and turn pinkish white. It is then set completely hard by heating to 140° to 150°F for 1 to 1½ hours. Although quicker setting methods with acid-hardening Bakelite are possible, they are less reliable than the one above described. One disadvantage of the above method is that the resin must be reasonably fresh, otherwise it does not "set" properly.

After mounting in Bakelite or in copper, the sample is ready for polishing. Using first a fine file and thereafter in succession on revolving discs four differently graded emery papers (Nos. 1, 0, 00, 000, made especially for microscopic work), the specimen surface is brought to a smooth state. Only a light pressure must be used, to avoid drag, and when changing from one paper to the next in fineness, the sample should be turned 90° and polishing continued until previous scratches are entirely obliterated when examined under a magnifying glass. Likewise, when changing to the next emery paper, specimen and fingers should be washed free from the coarser emery. Finally the specimen is polished on a revolving disc covered with cloth and frequently wetted with levigated alumina or a finely divided iron oxide suspended in water. In the case of very soft metals, like white metals, it is advocated, in order to prevent drag and distortion, to use a solution of paraffin wax in kerosene on the emery papers and, on the cloth wheel, a soap solution in addition to the levigated alumina or iron oxide suspension.

When now examined under the microscope, the specimen should be substantially free from scratches when viewed at about 1000 magnification. The division line between electroplate and basis metal on the one side and between electroplate and copper support on the other, should be clear cut, as in Fig. 9. This figure is reproduced here not as exemplary, but rather as indicating the

Fig. 9. Illustrating color differences between the various metal layers. Note sharp boundaries. This is the least polishing that can be given a specimen to obtain satisfactory results. 1000*X*.
(*From June issue*)

minimum amount of polish required. If unevenness or fringes occur, not to speak of patches of, for example, a white deposit or brass metal found in the red copper support, it is evidence that one should repolish by returning to the last emery paper.

If one is only interested in making a thickness measurement of the deposit, it is hardly necessary to etch the microsection. A magnification of 1000 is usually most convenient rendering a plate thickness of 0.001″ as a band 1 in. wide on the screen or ground glass as well as on the photomicrograph. It should be said that in case a copper deposit is under investigation, this should, for better definition, be covered by a short time plate of a white metal—such as nickel or silver—before applying the outside copper support.

In cases where a further study is desired of the deposit, or of its structure, the underplates, basis metal, alloying bonds, etc., it becomes necessary to etch the specimen. What etching solution to use depends naturally upon the basis metal, upon the electroplates present, and upon the particular center of interest. For example, in Fig. 2 we

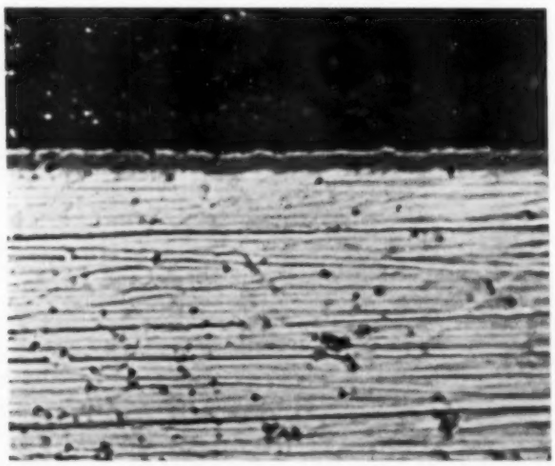

Fig. 2. Illustrating a silver plate protected from tarnish by top plates of palladium and rhodium. Note difference in whiteness between the three metals. A—rhodium; B—palladium; C—silver. 2000*X*.

(From June issue)

were interested in the palladium and rhodium deposits to determine if their thickness corresponded to what was expected according to the ampere-hours used in plating. We were not interested in bringing out the structure of any of the deposits, but, were it so desired, the etching solution would most likely have attacked and widened the boundary line between electroplates and basis metal, as may be noticed on many of the photomicrographs. This is not helpful when making thickness measurements of thin deposits. However, it proved necessary, in order definitely to locate the division line between the rhodium top plate and the mounting, to etch the latter dark. An etching method was, therefore, selected which would do this without causing any other parts of the specimen to be attacked, after which the thickness of the deposits could be accurately measured at a linear magnification of 2000.

Considerations of this nature always have to be taken and quite often it is necessary to repolish on the cloth

Fig. 13 illustrates how poor plating is sometimes caused by defects in the basis metal and Fig. 14 contrasts crystalline, brittle copper with the finer-grained, tougher copper of Fig. 15.

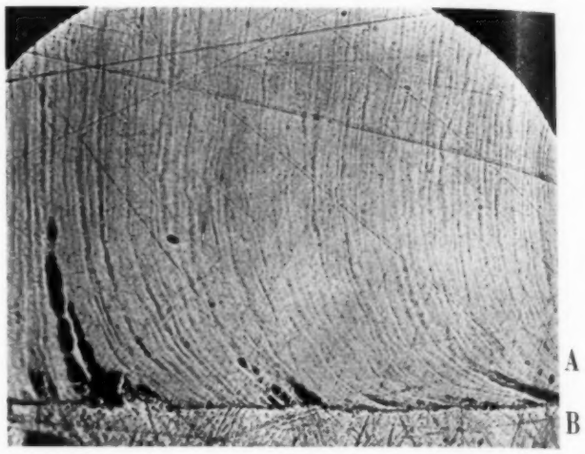

Fig. 13. An example where defects in basis metal cause defects in deposit. A—edge of nickel silver basis metal trimmed in a die; B—silver plate. 200*X*.

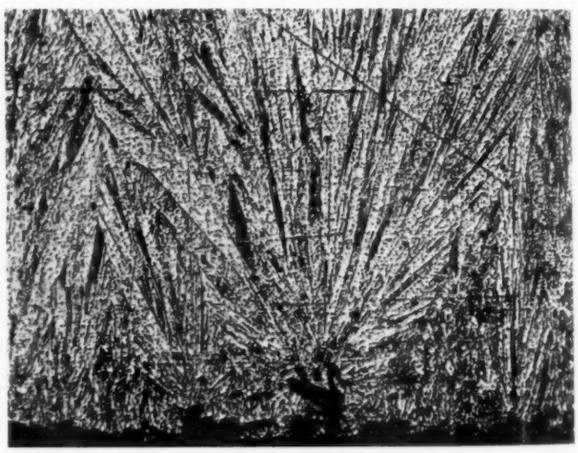

Fig. 14. Coarse grained copper plated from an acid bath. 200*X*.

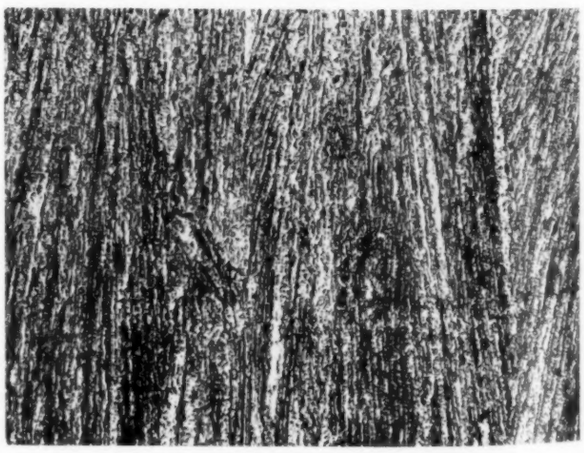

Fig. 15. Fine grained copper plated from an acid bath.

wheel, and re-etch before the required contrast is brought out. This is often done also to remove the distortion of the metal surface that has taken place during polishing, especially with the softer metals. In such cases the underlying, true structure of the metal may not have been exposed after the first etching and unless one is very experienced, one should always repolish at low pressure and wheel speed, and re-etch until no change in structure is observed. Sometimes the etching solution does not work normally because of interference due to a local battery setup between the material from which the clamp is made, the mounting material, basis metal and electroplates. In such cases, it is helpful not to immerse the specimen in the etching solution, but to take a drop of it on the tip of the finger or on cotton and to rub it gently back and forth over the specimen until the required depth of etch is procured. Bakelite mountings have in this respect an advantage over metal mountings, but much can be done by using the insulating fibre layers above referred to and by having clamps made from a few different materials. For example, one should not use a stainless steel clamp with a specimen made from a copper-nickel alloy, etc. The time or depth of etching is very important and the requirement varies with the magnification one plans to use. Usually the higher the magnification, the milder should be the etch.

All told, polishing and etching is an art, and to become a master, which is a state only attained by few, takes considerable experience and power of observation. In fact, it is the most difficult part of microscopy as applied to electroplates. However, even with a moderately good technique, such as is attainable by every one, the microscope renders most valuable information.

Often one wants only part of the composite sample to be etched, in which case, one would use a selective solution. In other cases one desires a uniform etch on all composite parts, and though it is possible in many cases to find a universal etching solution, it is quite often necessary to etch the specimen in several solutions to obtain the desired effect. A multitude of solutions and possibilities exist and almost every technician has his favored solutions and methods. The list of etching reagents given below is, therefore, offered as suggestive only. In many cases, it is not possible to give a uniform etch to all parts of a composite sample, such as a highly noble metal electroplate covering a base metal article. Such strong reagents are required to attack the noble metal that by the time its structure is developed the base metal is over-etched to an extent making it entirely useless for microscopic observation. If, in such cases, it is absolutely desired to make an investigation of the structure in both basis and plate, they may be etched, observed and eventually photographed separately.

The polished specimen, when viewed under the microscope, shows in general no trace of its structure because all incident light has the same directional reflection from the entire area. However, it is possible in many cases to distinguish between electroplates and basis metal because of films in the boundary; and in the absence of such evidence, there may be sufficient difference in color between the metal layers to make them discernable. In this photo, it is impossible, however, to draw any further conclusions than that the specimen consists of at least three metal layers of different color or whiteness. By etching, the chemical and physical distinctions between layers, and between constituents within each layer, are made visible due to their increased optical contrast. This is made possible by selective attack of the etching solution on metal layers and constituents of varied chemical composition.

(The concluding part of this article with the etching solutions to be used will appear in the August issue).

In Fig. 16, a copper electroplate has diffused into the zinc base on ageing. The method of applying the metal coating can also be determined by means of the microscope, Fig. 17 showing the appearance of hot-dipped zinc as compared with the electroplated zinc of Fig. 18.

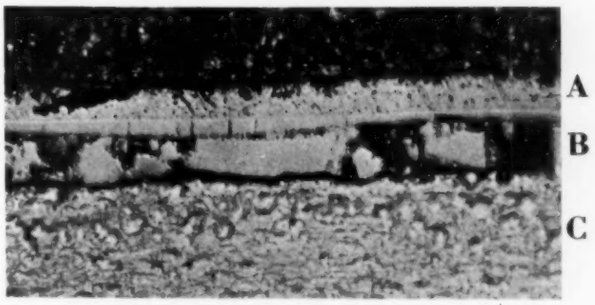

Figure 16. A—undiffused copper; B—brittle diffused alloy; C—basis metal.

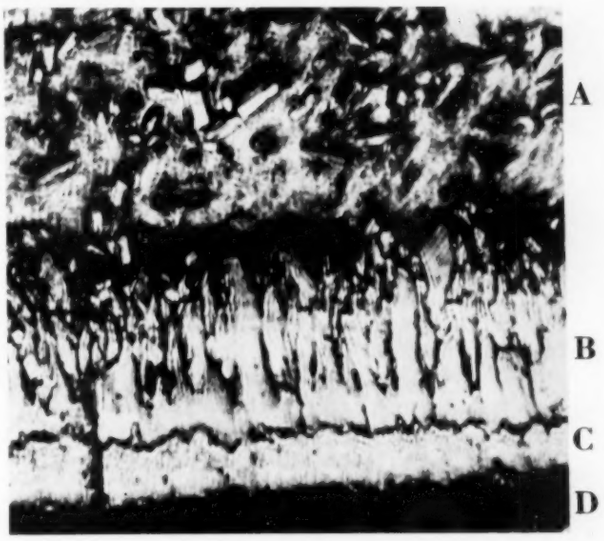

Figure 17. Hot dipped zinc coating. A—free zinc; B—$FeZn_7$ alloy; C—Fe_3Zn_{10}; D—basis iron 1000X (after Meyer).

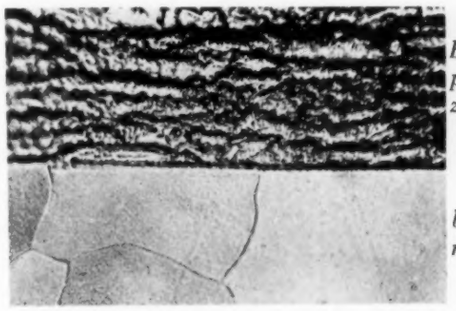

Figure 18. Electroplated zinc from acid solution.

The Thickness of Wet and Cured Paint Films

By Willoughby Sheane

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The author discusses and develops the relationship between wet and cured film thicknesses of industrial organic finishing materials on the basis of the non-volatile content. An example of how this information can be used is given, along with a chart for easily securing the answer to any problem.—Ed.

In many instances it is desirable to know the thickness of the full wet paint film[1] which has produced a particular dried or baked (i.e., cured) film. Conversely, it is sometimes of interest if a prediction can be made as to the full wet film which must be applied in order to produce a cured film of a prescribed thickness. Instruments for measuring wet and cured film thicknesses may be used to obtain direct measurements, the Pfund wet film gauge and the General Electric film thickness tester for cured films being of particular value for their respective purposes. However, difficulty is sometimes encountered, particularly in the measurement of wet films, where the rapid evaporation of volatiles may cause progressive film shrinkage and make duplication of results almost impossible.

If certain data are known, the relationship between full wet and cured film thicknesses may then be calculated. The basis for such a calculation is the assumption:

$$Ws = Wc \qquad \text{(Eq. 1)}$$

where:
Ws = the weight of non-volatiles in a full wet film of given area
Wc = the weight of the cured film resulting from that full wet film

Consider a section of a full wet film (Fig. I) of area (A) and thickness (Tw). If the density of such a full wet film composed of volatile and non-volatile components be designated (Dw), if the per cent by weight of non-volatile content be designated (Ps), and if the density of the film due to the occupancy of the volume (A·Tw) by the non-volatile components *alone* be designated (Ds), then:

$$Ds = \frac{(Ps)\ (Dw)}{100} \qquad \text{(Eq. 2)}$$

whence:

$$Ws = (A)\ (Tw)\ (Ds) = \frac{(A)\ (Tw)\ (Ps)\ (Dw)}{100} \qquad \text{(Eq. 3)}$$

Further, consider this full wet film of area (A) and thickness (Tw) after curing (Fig. II). Due to the curing process, the density has become (Dc) and the film thickness (Tc). Whence:

$$Wc = (A)\ (Tc)\ (Dc) \qquad \text{(Eq. 4)}$$

Making Equations (3) and (4) equal as expressed by Equation (1) and cancelling (A):

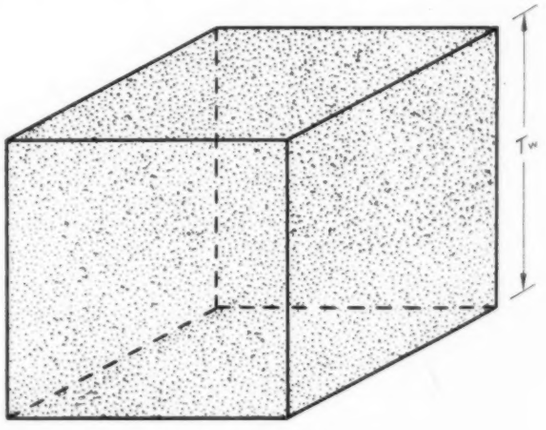


Figure I

$$Tw = \frac{Tc\ (100)\ (Dc)}{(Ps)\ (Dw)} \qquad \text{(Eq. 5)}$$

whence:

$$Tw = Tc\ \frac{(833)\ (Dc)}{(Ps)\ (W)} \qquad \text{(Eq. 6)}$$

where:
Tw = full wet film thickness—inches
Tc = cured film thickness—inches
833 = constant

(1) Author's Note: This discussion uses the term full wet paint film to indicate a film which has lost none of its volatile content.

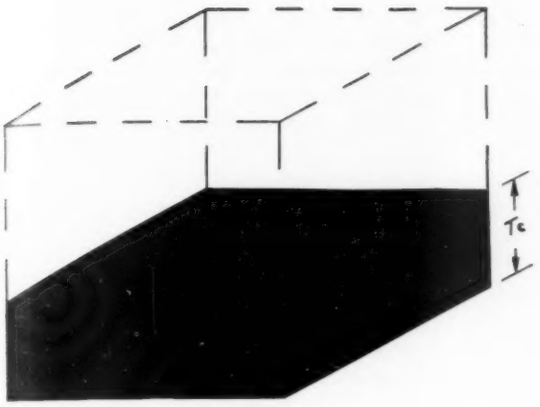
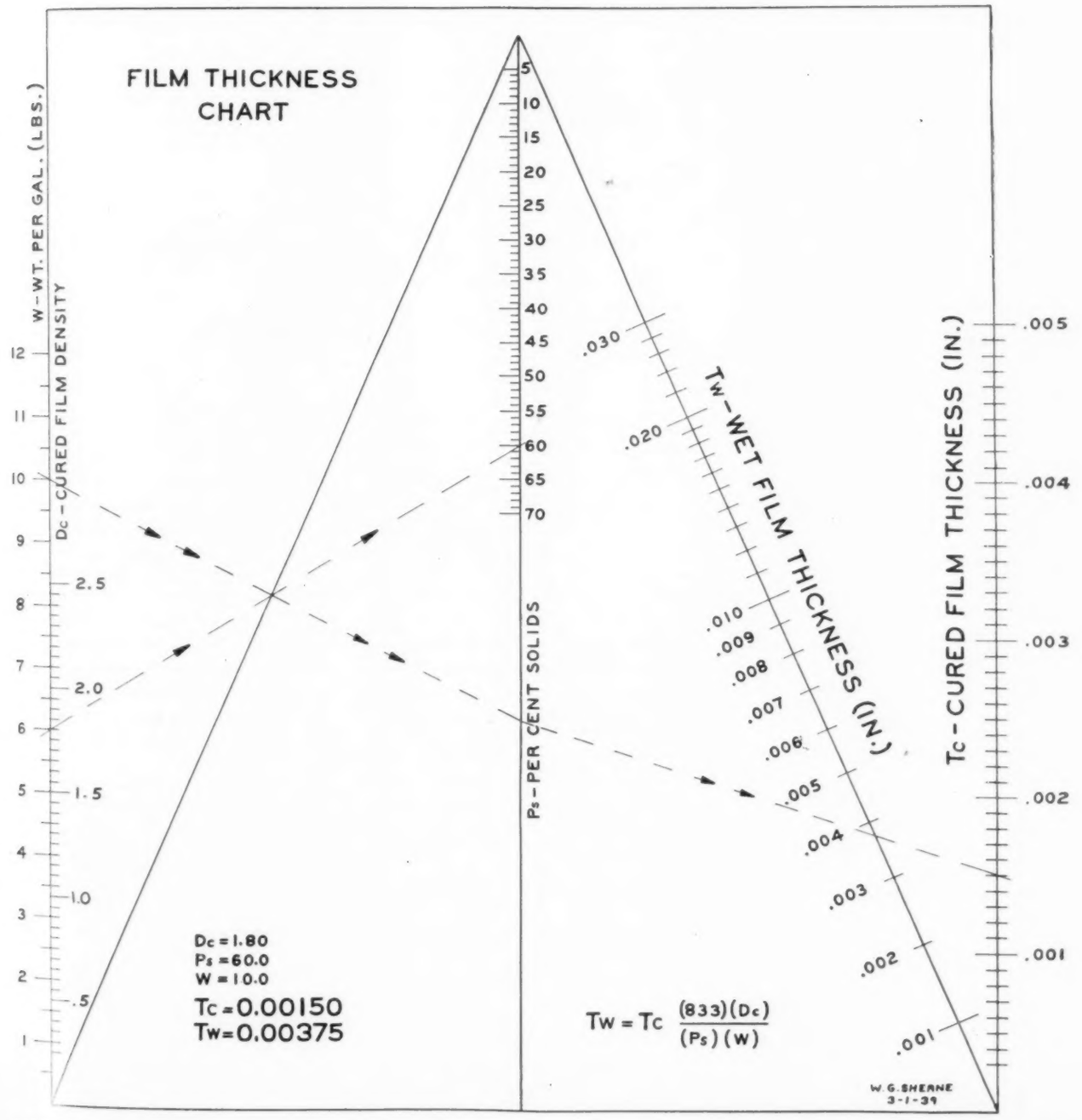


Figure II

Dc = density of cured films—grams per cubic centimeter
Ps = per cent by weight of non-volatiles in full wet material
W = weight per gallon of full wet material—pounds

Explanation of the Quantity Ds

The quantity (Ds) is not the true density of the non-volatile materials. It is a hypothetical figure based on the consideration of the removal of the volatiles but maintaining the non-volatile components in the total volume originally occupied by the full wet film. In other words, it is the density of the non-volatiles if their physical distribution as it occurs in the full wet film were maintained after removal of the volatile matter.


FILM THICKNESS CHART
W - WT. PER GAL. (LBS.)
Dc - CURED FILM DENSITY
Ps - PER CENT SOLIDS
Tw - WET FILM THICKNESS (IN.)
Tc - CURED FILM THICKNESS (IN.)
Dc = 1.80
Ps = 60.0
W = 10.0
Tc = 0.00150
Tw = 0.00375
Tw = Tc (833)(Dc) / (Ps)(W)
W. G. SHEANE
3-1-39

Example

An organic finishing material weighs 10.0 pounds per gallon (W), contains 60.0 per cent by weight of non-volatiles (Ps), and cures to give a film whose density is 1.80 grams per cubic centimeter (Dc). What full wet film thickness (Tw) must be applied if the cured film thickness (Tc) is to measure 0.0015″.

Substituting these values in Equation (6):

$$Tw = 0.0015'' \frac{(833)\ (1.80)}{(60.0)\ (10.0)} = 0.00375''$$

It is to be noted that Equation (1) is said to be an assumption. This is stated for the particular benefit of those industrial finishing materials containing predominantly oxydizing type resins. Materials which cure by the loss of volatiles alone, or by polymerization, follow the assumption almost exactly. However, due to the absorption of oxygen by oxydizing type resins, the weight of the cured film will be more than that calculated from the weight of the non-volatile portion of the full wet film. Still, the assumption is not greatly in error since practical tests have shown that although oxygen is absorbed, the total effect on the final equation is not as large as might be expected.

The accompanying chart (Fig. III) provides a rapid method for obtaining the relationship between wet and cured film thicknesses. The dotted lines and the data given on the chart constitute an example showing its use.

Maintaining First-Aid Fire Protection

By Leonard F. Mäar

Safety Research Institute

The author discusses fundamental rules for charging and maintaining fire extinguishers.—Ed.

Good judgment counsels and fire insurance regulations require the presence of adequate first-aid fire extinguishing equipment in the finishing rooms and other departments of the metal working plant. However, more than the mere presence of this equipment is necessary. It must be maintained properly to be ready for effective use in the instant that a fire emergency occurs.

The appearance of fire extinguishers on the walls of your plant may afford a feeling of security. But are you certain that every one of them —particularly the one that will be needed next—is ready for use?

Practically the only thing that will prevent an extinguisher from functioning properly is some fault in servicing it. If a unit is improperly charged, or if some part is defective, the persons responsible for inspecting and maintaining the equipment, and not the extinguisher, are to blame.

Fire extinguishers are just about fool-proof in their operation. Turn them upside down, or pump them, and they go to work. The job of recharging them and keeping them in service is just about as simple, but a few fundamental rules must be observed.

If the task is supervised by a plant fire chief there is little danger of errors of omission or commission. He knows how necessary it is to have the extinguisher ready for use when it is needed. But often enough, the work is relegated to workmen unfamiliar with the job. Then, trouble begins.

Two items of information should be available about each extinguisher of every type—fixed or portable—in the metal working plant. These are the date of the last recharge and the name of the man doing the work.

It is customary to keep this information noted on the tag which is furnished with each new extinguisher. In many plants, new tags are used each time the equipment is recharged. Care should be taken that these tags are not torn loose and lost.

When portable extinguishers are recharged, several routines are followed. Pails, sticks for stirring the chemical solutions, the recharging materials and a supply of replacement parts often are taken directly to the stations where extinguishers are hung. In this manner, the extinguisher is out of service for only a short time and is not moved from the point of hazard it protects.

In other plants, extinguishers are taken outside the buildings and workers are given an opportunity to discharge the old contents and so become accustomed to handling them. As soon as the units are emptied, they are recharged and returned at once to their stations.

Whatever the routine, there should be no deviation from the accepted practices involved in the actual recharging of equipment. In servicing fixed systems and special devices, care should be taken to follow exactly the

special directions received from the manufacturer.

A supply of replacement parts for all types of extinguishers used in the plant should be available to the men doing the work. These supplies and the recharging materials should be obtained from the manufacturer of the particular extinguishers in your possession. Use of inferior or improper parts may impair or destroy the efficiency of the unit.

Recharging

In the attached chart, the source of pressure of each type of extinguisher is indicated. This is a clue to accepted recharging practices.

When the pressure is internal, or the result of chemical reaction within the unit, the charge should be renewed annually. Care must be taken to wash all parts (of extinguishers using water solution with chemicals) thoroughly with water and to drain the water through the hose. This is done to rinse out the vestiges of the chemicals and of the products of their reaction, so that when fresh chemicals are put into the unit there will be no slow re-action to weaken the force of the extinguishing stream before the unit is next used.

The powdered chemicals for this, and all other types, should be thoroughly dissolved in water outside the extinguisher in exact accordance with the instructions on the extinguisher. For the chemical solution (soda-acid) extinguisher, the water should be preferably lukewarm, but not hot. For foam units, use separate containers for dissolving the different chemicals; preferably, use hot water for the "A" or acid charge, and lukewarm water for the "B" or foaming agent. Where temperatures lower than 40° F. may be encountered, the chemical solution (soda-acid) and foam type units should be kept in suitably heated cabinets to protect them from freezing.

In dissolving anti-freeze crystals and chemicals for extinguishers of this type, separate containers should be used. Stir the solutions vigorously to make certain all the chemicals are dissolved.

For the loaded stream type, if the chemical is not obtained in solution, the same care should be taken to dissolve it thoroughly before the solution is placed in the extinguisher.

Be certain to fill all extinguishers to the filling marks which appear plainly on the inside of the shells.

Inspection

All extinguishers should be inspected annually and also when they are recharged after use.

Head gasket and hose should be examined and if they show signs of deterioration, they should be replaced. Inspect the strainer and clean it.

Examine the shell to make certain it is tight at the seams, for, after all, it is a pressure container. If the shell has been damaged by dropping it accidentally, or in some other fashion, it should be sent back to the manufacturer for repairs.

When the cap is screwed back on the shell, the worker should be certain that at least four threads are engaged. This is a requirement of the Underwriters' Laboratories. A small amount of vaseline may be placed in the threads to make the task easier and to facilitate removal for the next recharging.

The pump action anti-freeze and water type extinguishers require a little special attention. Test the pump for several strokes, pumping the liquid back into the tank through the filler hole.

Inspection of the stored pressure units involves weighing the cylinder or cartridge of carbon dioxide from which the pressure is obtained. Loss of one-half an ounce is cause for replacement.

The pump action of the vaporizing liquid extinguishers must be tested by pumping some of the contents into a clean, dry container. The test liquid can be poured back into the unit through the filler opening. Add additional liquid to bring liquid level to normal, if necessary. Guard against overfilling. Swing the extinguisher back and forth to remove liquid left in the discharge tube before replacing the unit back on the wall. Use no lubrication on the piston of this type extinguisher. Never use water to wash or test the unit.

The carbon dioxide extinguisher is inspected by comparing its weight with that stamped on the unit. Loss of ten per cent in weight indicates the need for recharging. Note if the seal attached to the operating valve is intact.

On the chart, we have indicated that an "outside inspection" is recommended every three months. By this is meant that no more than the exterior of the extinguisher is involved in the work. Each unit should be lifted down from its hanger to make certain it is filled. The nozzle of the hose should be examined to make certain it has not been clogged.

This quarterly inspection takes but a short time and is important to the quality of fire protection administered in your plant.

Suitability

Class A fires are those in ordinary combustible materials such as wood,

Fire Extinguisher Maintenance Chart

Type	Source of Pressure	Suitability	Recharge Interval	Complete Inspection	Outside Inspection
Chemical solution (S&A)	Chemical reaction	Class A fires	Yearly	Yearly	Quarterly
Water	Chemical reaction, pump or stored	Class A fires	After use	Yearly	Quarterly
Anti-freeze	Pump or stored	Class A fires	After use	Yearly	Quarterly
Foam	Chemical reaction	Class A & B fires	Yearly	Yearly	Quarterly
Loaded stream	Stored	Class A & B fires	After use	Yearly	Quarterly
Vaporizing liquid	Pump	Class B & C fires	After use	Yearly	Quarterly
Carbon dioxide	Stored	Class B & C fires	After use	Yearly	Quarterly
Dry chemical	Stored	Class B	After use	Yearly	Quarterly

paper, textiles, etc., where the cooling and quenching effect of water is of first importance.

Class B fires are those in inflammable liquids, such as gasoline, oils, greases, paints, etc., where a blanketing effect is essential.

Class C fires are those in live electrical equipment where the use of a non-conducting extinguishing agent is required.

Resume of papers presented at annual meeting of the American Electroplaters' Society.

(*Continued from page* 316)

Tests on nickel plated brass showed little porosity unless deposits were thin. To test deposits over zinc die castings, salt spray test is best.

Abner Brenner

Dropping Tests for Zinc and Cadmium on Steel

A. Brenner

Description of methods used at Bureau of Standards.

Using the antimony trichloride stripping test as an umpire, dropping tests were compared for accuracy. The coatings tested were electroplated zinc, hot-dipped zinc and sherardized zinc. The basis metals were mild steel and malleable iron. With the use of the ammonium nitrate reagent recommended by Clarke no satisfactory endpoint could be obtained for cadmium and electroplated zinc on cast steel. The use of chromic acid reagent gave superior results. Tests made with the jet method are unsatisfactory as the endpoint is difficult to discern. The magnetic method has the advantage of not destroying the specimen. It is about as accurate as the chromic acid dropping test. Burnishing the deposit improves the reproducibility of the results. 20% tolerance should be allowed for error. Recommends chromic acid reagent in preference to ammonium nitrate. Illustrated.

The Measurement of pH in Alkaline Plating Solutions

M. R. Thompson

A study of the methods for measuring pH in alkaline solutions.

The true pH of a solution is that determined by a hydrogen electrode. The glass electrode can be used in alkaline solutions but it is subject to error. It is affected by sodium salts. Colorimetric tests were also made. Results seem to indicate that it is difficult if not impossible to determine the true pH of alkaline solutions. In cyanide solutions, the glass electrode is about 1 to 1½ pH units too low. The colorimetric method gives values about ½ unit too high. Any method can be used to obtain relative results provided however a standard procedure is employed.

Some Effects of Anode Shape and Position on Cathode Current Distribution

Dr. C. Kasper

Theoretical discussion.

By use of conformal representation (mapping) it is possible to solve many problems of potential and current distribution in space and apply them to electrodeposition. A series of equi-potential surfaces exist between two electrodes and the lines of current flow are at right angles to these surfaces. Actual mathematical solutions of specific cases indicate that current cannot be thrown into recesses by the use of stop-offs and that the use of elliptical anodes is unfounded. Several particular cases are solved and illustrated, notably, current flow through holes, around interference, from angular recesses.

Dr. Charles Kasper

A Study of Silver Plating for Industrial Applications

C. S. Lowe and A. C. Simon

Description of research conducted by American Silver Producer's Research Project.

The ferroxyl test cannot be used for determining porosity of silver coatings as the ferricyanide attacks silver. Four different basis metals were used for silver deposits: copper, bright finish steel, mirror finish steel and tin can stock. For the thin silver coatings plated, no porosity method is accurate. Treatment of the basis metal and suspended matter in plating solutions have definite effects on porosity. The basis metal used, the plating method used and the thickness of deposit also affect porosity. At present time 0.001" seems to be the minimum thickness of silver that can be plated without porosity. Heavy deposits of silver can be deep drawn without affecting porosity. Illustrated.

A. C. Simon

PLATING AND FINISHING
FABRICATION — ASSEMBLING
METALLURGICAL — ROLLING
CASTING AND JOINING

SHOP PROBLEMS

Technical Advisors For July Issue

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Chase Brass & Copper Co.,
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DR. K. SCHUMPELT
Baker & Co., Inc.,
Newark, N. J.

When sending solutions for analysis please give following information: name and address; class of work being plated; kind of solution and volume; length, width and depth of tank; temperature of solution; current density, cleaning sequence and any other pertinent facts.

Full information is necessary in order to render proper service.

Anodes Out of Junk Copper

Q. We have a customer who wants to make anodes out of junk copper. We would like to know how to plate, the size of tanks and the electrolytes required to plate out metallic copper, which is alloyed with other metals.

A. The recovery of pure copper electrolytically from various alloys containing copper cannot be accomplished with satisfactory results. This perhaps may seem to be a rather broad statement but it is based on a very careful survey made of a similar attempt by one of the largest copper and brass producers in the country, which met with failure after the expenditure of many thousands of dollars.

Various methods were used to put the copper alloys into solution for use as acid or alkaline electrolytes. The cost of doing this alone was almost prohibitive as the alloys were extremely slow in going into solution. Naturally, other metallic elements were also dissolved in the electrolyte and after the copper was recovered by electrolysis, a certain percentage of these other elements were also deposited. The percentage was large enough to poison the copper recovered rendering it unfit for commercial purposes even as anodes.

The electrolysis was carried out in both cyanide and sulphuric acid solutions with pure sheet copper used as starting cathodes. The baths were operated under various conditions but in no instance was anything like pure copper obtained due to the contamination of the electrolyte with other metallic elements.

The cost of the impure copper thus obtained was three to four times more than it could be purchased on the market. After many attempts to recover pure copper from scrap metal alloys containing copper, the entire venture was discarded as impractical due to the high cost and the quality of the copper recovered.—T.H.C.

Faulty Nickel Solution for Plating Die Castings

Q. We are sending under separate cover a sample of our die cast nickel solution. We cannot get this solution to work correctly. It seems that the work comes out with dark streaks. We have tried several ways to get this solution to work properly, but without good results.

Original formula of solution is as follows:

Water	1 gal.
Single nickel salts	10 ozs.
Nickel chloride	3 ozs.
Sodium sulphate	22 ozs.
Boric acid	3 ozs.
Gum Arabic to 100 gal. solution for brightener	1 oz.

A. The analysis of this solution is as follows:

Metallic copper	3.0 oz./gal.
Chloride as nickel chloride	1.8 oz./gal.
pH	5.0

The chloride content is low and the nickel content is high for die cast work but the fundamental fault is the low pH. There is a tendency for zinc to go into solution and precipitate nickel on die castings when immersed in an acid nickel solution. This results in streaks on the work. The effect is minimized by maintenance of a low metal content of about 2 oz./gal., a high sulphate concentration and a high pH corresponding to a low acidity.

It is suggested that 1/3 of the solution be removed in order to cut the metal content down to 2 oz./gal.

This will, at the same time, remove 1/3 of the dissolved zinc. After replacing with water, 2 oz. each per gallon of ammonium chloride, and boric acid should be added, also 3 oz./gal. of anhydrous sodium sulphate. The pH should be raised to about 6.2 which will require the addition of approximately 5 fluid oz. of ammonia to each 100 gals.—C. B. H., Jr.

Gold Plating

Q. We are interested in securing information regarding the following: (1) a process to gold-fill electrolytically a case (watch), at a thickness of 40 microns (1 micron being the thousandth part of one millimeter); (2) at a gold standard of 10 or 11 karats; (3) so that the coating does not need any brushing during the operation of plating and that the plated object comes out brilliant from the bath. Is it possible to have a good quality coating which gives the object any wanted color without using a second bath?

A. It would be possible to electrodeposit fine gold on a watch case to a thickness of 40 microns, but under conditions commonly employed in the commercial field the deposit would not be bright. It would require coloring after plating to bring up a luster.

On the point of depositing a heavy layer as above but of definite alloy composition, rather than fine gold, it can be stated that this would be a difficult matter. Present methods for plating karat gold colors do so from a control of the color of the deposit, and not control of its composition. Also, the karat shades obtained by electroplating are usually flash deposits. Where heavy gold coatings are desired to be finished in some particular karat color, the practice is to heavy gold plate in a fine gold solution and then finish the article by flashing in a karat gold solution of desired shade.

The color of a karat can be approximated by the addition of copper to a fine gold solution. The composition of the resulting deposit will be different from the composition of fabricated gold of the same karat color. Thus an electrodeposit that would analyze to be 22K would have a color of 14K fabricated gold.

Nickel may be added as a salt to the gold solution to increase hardness, but the amount must be very small and the current conditions closely controlled so that the amount of nickel in the deposit will not affect the color.

Alloy gold deposits may be produced by the Bek process. For a description of this process see page 295 of the August 1936 METAL INDUSTRY, "The Bek Process" by Dr. Louis Weisberg.

For your information, the Federal Trade Commission ruled in 1923 that a minimum of 0.003″ outside and 0.001″ inside is necessary to use mark "gold filled" on watch cases.

—G. B. H. Jr.

Yellow Silver

Q. We are having difficulty with our silver deposits having a yellowish cast, as they come from the plating bath.

Will you please let us know what may be the cause of this trouble. We also observe crystal formation in the bottom of the tank and these crystals are dissolved when the solution is heated.

A. In a case of this type, it is necessary that the solution be analyzed before any positive recommendation can be made. A yellow-appearing silver may commonly be due to the presence of excess iron or copper in the plating bath. Since iron tanks are most commonly used and since the chloride content of the bath is high in this case, it may very well be that iron is responsible for the trouble. If so, the only remedy is either to make a new solution or at least to replace part of the poor bath by new solution, thereby reducing the iron concentration. Silver cyanide and not silver chloride should be used. The ammonium chloride should be omitted. For replacing part of the old solution, use 3½ troy ozs. silver cyanide and 5 av. ozs. sodium cyanide for each gallon of water used. It has been assumed that the cyanide content of the original solution has not been allowed to drop appreciably below the value stated in the question.

The crystals at the bottom of the tank are probably sodium carbonate, formed from the sodium cyanide. Sodium carbonate is much more soluble in warm solutions than in cold, which accounts for the crystals disappearing when the solution is heated. These crystals should be removed from the cold solution by filtering or by decanting (drawing off) the clear solution above them. They may then be sent to the refiners for recovery of the silver left on them. The plating solution will be found to give better results after this treatment.

—Research Electrochemist.

Tanks for Rhodium Plating

Q. We would like to know what type of tanks should be used for our rhodium plating solutions.

A. The best material for small units up to 5 gallons is pyrex glass. The regular pyrex beakers can be used up to about 1 gallon. Tanks are available with capacities from 3 to 4 gallons, having inside diameter of approximately 7½″ to 8½″. A sturdy flange around the edge makes it easy to set them up in hot water or steam jackets. Battery glass jars or other rectangular containers of glass are not to be recommended on account of the danger of cracking when heated.

For larger tanks, stoneware tanks, round or rectangular, are best. When placing the order, it should be specified that the glazing must be of the highest quality, without pores or hair-cracks. We understand that special stoneware tanks with highly fired glazing of greater density are available.

When placing such stoneware tanks in hot water jackets, the following precautions should be taken:

1. The bottom of the stoneware tank should be carefully supported in several places by bricks or wooden blocks. Enough space should be left under the bottom and between the walls.

2. Steam pipes for heating should be placed in such a manner that they do not come close to the stoneware tank to avoid non-uniform heating.

3. A steam coil should be used for heating rather than blowing live steam into the water.

If properly taken care of, stoneware tanks up to 100-gallon size have given satisfactory service over many years.

Glass lined steel tanks are available, but they are much more expensive than the other types of tanks mentioned. Rubber lined tanks are not recommended for rhodium solutions because of the danger of spoiling from traces of organic substances, such as the accelerators or anti-oxidants which may be present in the rubber.—K.S.

ELECTROPLATING DIGEST

SELECTED ABSTRACTS ON PLATING—FINISHING—RUST PROOFING—LACQUERING

A Resume of Lead Plating

Joseph B. Kushner, Ch.E.

(Concluded from the June issue)

III. *The Perchlorate Bath*

This type of bath was first patented by Mathers[17], in 1909. The prototype formula due to him is:

Basic lead carbonate	8	oz./gal.
Perchloric acid $HClO_4$	5.3	"
Oil of cloves	0.5	"

Temperature 65°F. Current density 19-27 amps./sq. ft.

A bath given by Weiner[18] is:

Lead perchlorate	50	grams/liter
Perchlorate acid	10	"
Peptone	0.20-0.4	"

Temperature 60°C. Use vigorous agitation. Current density 27-36 amps./sq. ft.

IV. *The Phenolsulphonic Bath*

This bath was first patented and described by Betts in 1908. A composition used by V. P. Fedotieff[16] is as follows:

Free phenolsulphonic acid	8.7	grams/liter
Lead phenolsulphonate	183.3	"
Glue	2.3	"

Current density ½-3 amps./sq. dm. 100% current efficiency.

V. *The Alkaline Tartrate Bath*

This is a comparatively recent type of bath being originally patented by Gravel in 1936[19]. The formula taken from the original patent is:

Lead oxide (PbO)	100	gr./liter
Rochelle salts	110	"
Potassium hydroxide	55	"
Gelatin	0.5	"

Temperature 40°-50°C. Current density 100 amps./sq. meter. Voltage 0.3 volts.

Several other types of alkaline baths have been proposed but unfortunately thick deposits cannot be obtained with them and anode efficiencies with them are very low so they will not be described.

All of the above-mentioned baths, with the exception of the last mentioned one, have been critically evaluated by the Russian workers[20], and Blum and his co-workers[21] who found the fluoborate bath best because, (1) under similar conditions, it seems to give finer grained deposits, (2) it is easier to mix and make up in commercial quantities, (3) it is less susceptible to decomposition such as occurs in the fluosilicate bath (break down to silica and lead fluoride), (4) it permits wider variation in temperature, metal concentration, etc. The perchlorate bath is also excellent but it has not been used much because of the erroneous notion that the perchlorates by themselves are very explosive. (An aqueous solution of perchlorate is very stable and definitely will not explode). The alkaline bath containing tartrate has not been yet sufficiently tried so that an opinion may be formed, but according to Schmellenmeier[22], this solution yields fine-grained, bright deposits.

Blum and Hogaboom[23] state that ferrous metals should be sand-blasted in preference to being pickled before lead plating, as the hydrogen formed seems to prevent adequate adhesion of the lead plate. Iron, before being lead plated, should be given a strike of copper from a cyanide bath for best results even though lead can be deposited directly if need be. Tin may be a possible substitute for copper in this respect as Joshi and Rao[24] claim a predeposit of this metal improves lead coating. Another important point is to rinse the deposit thoroughly and dry at once to prevent any oxidation of the lead deposit from alkaline baths. Pure lead anodes (at least 97%) should be used for all the previously described baths, as on insoluble anodes, a coating of lead peroxide (PbO_2) or basic lead salts is formed.

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Patents of Interest to Electroplaters

1. *Apparatus and Process for the Study of Plating Solutions.* American Patent No. 2,149,344. Granted March 7, 1939 to R. O. Hull. Assigned to E. I. Dupont de Nemours Inc.

The patent consists of an experimental plating tank of special design for obtaining and observing the effect of varying current densities on a metal cathode immersed in the plating solution under test. The cathode is so fitted into the apparatus that each unit of cathode area in a given plane is at a different distance from the anode.

(Continued on page 349)

Post Scripts

At Asbury Park

Day-to-day Diary of the Editor
June 18-24

Sunday, June 18—*home in Hartsdale.*

Heard that *Horace Smith* and the Newark Convention Committee went down to Asbury Park Friday noon—to make sure everything is shipshape and perhaps do a little celebrating—they certainly deserve it.—Sorry I couldn't join them.—I wonder if *Bill Erskine* and his wife *Mary* will drive all the way from Rockford, Ill.—Hope he isn't peeved for calling him "Fred Astaire."—Will *Phil Ritzenthaler* and *Vincent Sheehan* come from Milwaukee and will Phil's hair be as wild as ever?—*George Morrow* ought to give an even more bewildering exhibition of legerdemain as we heard he has added some new tricks to his repertoire.—Haven't seen *Bert Sage* for a year—hope he comes.—I must remember to take a cushion along for sitting through the educational sessions on the usual hard seats.—*George Hogaboom's* idea of having the speeches of the English authors made into a record should surprise them at Asbury Park.—We were grateful to have *Arthur Hothersall* as our guest at Hartsdale last Sunday.—We know that *Dr. Blum* and *Mrs. Blum* must have made him feel at home last week in Washington as they are the most pleasant hosts we have ever met.—Wasn't it *Tom Slattery* who visited them for a day when he first went to Washington and he stayed three years.—Will have to apologize to *Austin Fletcher* of Binghamton for saying in the June issue that he has two boys in addition to his new daughter. Those two boys belonged to *Larry Meyer* in Binghamton. Austin will probably be in for a little kidding until my story is straightened out.—If we want to overcome that "morning after the night before feeling" at Asbury Park, we can jump into the Atlantic ocean.

I can see why many of the men leave their wives home. It isn't just the extra expense at the Convention, it's those darn new dresses, shoes, permanents and other trivia that put us behind the eight ball financially for several months.—*Frank Watt* (Detroit) should be a seasoned daddy by this time—when I saw him last December he had that worried look of an expectant father.—Guess I will go to bed early as it will be my last good sleep for the next week.

Monday, June 19.

Packed and underway by 9:00 A.M. We decided to take our 4 year old daughter *Joan* but with some misgivings as to how she would sleep with all the racket in the hallway and adjacent rooms.—Got into an awful traffic jam driving along the Hudson River as we decided to go through the Holland tunnel so as to see the ships. Saw the gigantic Italian liner *Rex*, the *Queen Mary* and the *Deutschland* which brought back memories of the first International Conference on Electrodeposition held in London in 1937 as I traveled to Europe on the Deutschland. The *Kungsholm* was at her pier—*Oscar Servis* intends to travel on her to Sweden when he receives the $1,000 award this summer for 40 years of service with Felt and Tafrant Co., Chicago. The greatest thrill was to see the beautiful *Ancon*, one of the new ships of the Panama R.R. Line which has been subsidized with U. S. funds. Went past some vile odors going over the Pulaski skyway and noticed many famous plants—Western Electric Co., American Can Co., Pyrene Mfg. Co., Sherwin Williams Co., Worthington Pump, etc.

Arrived at Asbury Park about 11:00 A.M. just as it started to rain. Met dozens of acquaintances milling around the hotel registration desk trying to get a room. The usual answer was, "Sorry, all our rooms are taken, suggest you go to Hotel Monterey next door." Some of the familiar faces seen were: *Clayton Hoff* (DuPont Co.), *Eugene Phillips* (Puritan Mfg. Co.), *Fred Fulforth* (Proctor Electric Co.), and *Ed. Musick.*

Found that our room was next door to *Oscar Tyson* who was already laboring with the first edition of the H-VW-M Co.'s *Convention News*. *Louis Hague* was also doing yeoman's duty. Dropped in to see the H-VW-M Co. model of their new conveyor and saw *Dr. L. Weisberg* and *Dr. A. Ken. Graham* studying it carefully.

Two doors south was the Frederic B. Stevens room with *Al Hannon* as *Maitre d'Hotel*. *Frank Watt* and *Ed. Homan* appeared to be in high spirits but Al seemed a little worn from the effects of his recent operation.—Met *Dr. Blum* (in lobby) who said that *Paul Strausser* just had undergone a serious operation in Washington. We all missed Paul and hoped for his speedy recovery.—Had a short talk with *Edward Faint* (Mack Motors) who came in from Allentown leaving his sick wife and a daughter who was to undergo a serious operation.—Son *Harold* said, "hello". He's recently become sales manager of the Continental Roll and Steel Foundry Co., East Chicago, Ill. I was going to introduce Harold to *Joe Sterling* (G. E., Bridgeport, Conn.) but found that they were old acquaintances. Joe was one of Harold's pupils in a chemistry class which he conducted many years ago in Chicago.

Met *Wm. Belke* previous to the Fellowship luncheon who said that he had a new filter disc which I ought to see. Also said that "What-a-Man" Larry, the Tarzan of our story in the May issue, was kidded plenty about the story. I forgot to find out Larry's last name.

1938-1939 *officers of A.E.S. Left to right, W. M. Phillips, W. J. R. Kennedy, R. M. Goodsell and Fred Fulforth.*

At the International Fellowship Luncheon

The largest crowd ever, 107, sat down for the luncheon. *A. W. Hothersall* sat with the past chairmen.—*George Hogaboom* was disturbed that the luncheon, because of the large crowd, ran over into the time of the educational session. Perhaps it would be more advisable to start future luncheons earlier.—*Oliver Sizelove* started the members introducing themselves but towards the end of the introduction the only one to hear the introduction was the person introducing himself.—*Dave X. Clarin* (Oakite Co.) upheld his anecdotalistic honors but *George Morrow* (Egyptian Lacquer Co.) proved himself a leading contender.

John Oberender (Zapon Co.) rated honors as public and private defender of the Fellowship Club. John hasn't missed a convention since 1916. His first convention was attended, as a representative from the American Hardware Co., New Britain, Conn.

Popular *Jack Geissman* (Maas & Waldstein Co.) of Milwaukee was elected chairman, and a dark horse, *A. Fred Norgren* (Frederic B. Stevens, Inc.), New Haven, Conn., was chosen vice-chairman. You can learn more about Fred on page 344.

At the Monday Educational Session

I don't know what the "H." stands for in *Charles H. Proctor's* name, but it must be for hydrogen.—*A. W. Hothersall* presented a resume of his paper rather than reading it in entirety. This was a well appreciated kindness as it was very hot and sticky.—*The piece de resistance* of the afternoon was the broadcasting over the loudspeaker of talks by the other English authors. It was somewhat difficult to understand the talks, due to our unfamiliarity with English accents and pronunciations. *George Hogaboom* had kept this stunt secret and it came as a unique surprise to almost all present.

At the International Fellowship Party

The women had a problem in deciding the type of dress to wear. Should it be a plain dress, party frock or evening gown. Well, all three were worn. Many of the husbands were put on the spot as to their recommendations of the type of dress to wear with subsequent sidelong glances if their guesses went wrong.—*Tom Trumbour* had instructed the orchestra to play some "old time" music and not wear the people out with "swing." The music must have been O.K. as over 150 were still dancing when the music stopped at 2:00 A. M.

(To be continued in August issue)

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Joe Sullivan, secretary of the New Haven Branch, sent us some interesting notes, from which we have selected the following excerpts:

The annual banquet of the Chemistry Class of the New Haven Branch of the A.E.S. was held Saturday, June 3, at the Hejaz Grotto in New Haven. Some 90 members of the Chem. Class, guests from other Branches, and other guests attended this affair.

Preceding the dinner, the members enjoyed a bowling session and also some questionable pool shooting. *Bob Mooney's* sharpbreaking curve ball was an outstanding feature of the bowling. It not only broke right through the pin, but also broke Bob as far as betting was concerned.

The expert pool-shooting of *Joe Downes* ("that's the way I played it") and *Bill Bridgett* ("the cue slipped") made it possible for them to win a disputed match from *Henry "Dead-eye" Creamer* and *Tom "Masse-shot" Chamberlain.*

The dinner itself was a howling success. A fine "New York" floor-show featured by a very boot-i-ful akordeen player, some fine acrobatic and clog dancing, plus an excellent comedian and piano music, and *Charlie Koelbl's* inimitable pianoforte renditions all combined to make a most enjoyable evening of entertainment.

Following the dinner, *Dr. G. Vance* of the Yale Dept. of Chemistry and Instructor of the Chem. Class of the New Haven Branch gave a few complimentary remarks about the interest that was shown by the members in this work.

Briefs at Asbury Park

Al Braun of Agate Lacquer Co., said that his son *David*, who has been ill for some time, was much improved.

•

Cleveland Nixon (Ternstedt Mfg. Co.) astonished his companions with his modest breakfast on Tuesday morning of: (1) Steamed clams, (2) Clam broth, (3) Lobster, (4) Scrambled eggs, (5) French fries, (6) Tomato juice.

•

Austin Wilson's daughter is now almost as tall as dad himself.

•

George McLintock traveled up from the Panama Canal.

•

Mrs. Dorothy Fitch (United Chromium, Inc.) was one of the most charming women present with an ability to converse intelligently on almost any subject in addition to "Electrocolor."

Harold Faint looking at his ad in Metal Industry.

Carl Huessner (Chrysler Corp.) reported catching *Bill Phillips* (Gen. Motors), *Paul Savage* (McGean Chemical Co.) and *Floyd Oplinger* (DuPont) drinking buttermilk at a drug store, although Floyd later vehemently refuted Carl's testimony.

•

Past Presidents of A.E.S. Organized

At the convention there was organized, a Past Presidents' Club, which will meet at each annual convention of the A.E.S. and have a dinner. They will discuss items of interest in the electroplating industry happening throughout the United States, and will also try to remember each other at birthday time. The method of selecting the officers will be informal and the oldest past president who is at the convention shall preside, until every past president has served once. No one shall preside more than once until all who have attended the convention have presided at least once. *Frank Hanlon* of Chicago was elected permanent secretary.

All of the past presidents of the A.E.S. are living at the present time.

•

M. I. has some very faithful readers, one in particular is *A. Tinder* who is an enforced guest at the U. S. Northeastern Penitentiary at Lewisburg, Pa. Mr. Tinder has been a steady subscriber since 1937. His response to our data questions are: Position — inmate; Products — no department; Total Employees—none.

The two tallest members at the convention according to our reckoning were: *John P. Clarner* of Evans Case Co., N. Attleboro, Mass., and *Paul Bloom* of Egyptian Lacquer Co. Zapon's *Ed Bucy* wasn't present to defend his title.

•

Jack Geissman and *Jack Malool* rated tops as golfers.

•

There were many beautiful ladies in attendance—two of them caught our eye particularly; namely, *Mrs. Ralph Granquist*, Chicago, and *Mrs. Bradford Divine*, Utica, N. Y.

•

When *Gustave Klinkenstein* (M & W) spoke on finishing, all the competitive lacquer men were in the audience—even *Bob Mooney* was there.

•

The dubious prize award to the most sunburned went to *Clarence "Chick" Helmle* (G. E., Bridgeport). Chick was in a bad way Wednesday night, but his fighting spirit pulled him through.

•

Ralph McCahan said he has had to brush up on his palmistry after we labeled him "The Sage of Thornwood." Ralph is a dead shot with the rifle even at 3:00 A.M. *John E. Charleson* (Yale & Towne) also pulls a mean trigger.

•

Bill Newberry of Detroit Rex Products Co. was celebrating his 10th wedding anniversary.

•

A school of whales was spotted only a short distance off shore by *Floyd Oplinger* but he had difficulty in getting anyone to believe his story until corroborated by the "Prince of Sobriety," *Ed Christ* (Stanley Chemical Co.), by *Milton Hodges* (Electrolux) and the Sage himself, *Ralph McCahan.*

•

Around The Corner

By Charles Hanson Towne

Around the corner I have a friend,
In this great city that has no end;
Yet days go by, and weeks rush on,
And before I know it a year is gone.
And I never see my old friend's face
For Life is a swift and terrible race.
He knows I like him just as well
As in the days when I rang his bell
And he rang mine. We were younger then,
And now we are busy, tired men:
Tired with playing a foolish game,
Tired with trying to make a name.
"Tomorrow," I say, "I will call on Jim,
Just to show that I'm thinking of him."
But tomorrow comes—and tomorrow goes
And the distance between us grows and grows.
Around the corner!—yet miles away . . . .
"Here's a telegram sir . . . ."
"Jim died today."
And that's what we get, and deserve in the end:
Around the corner, a vanished friend.

Walter K. Meyer

NEW EQUIPMENT AND SUPPLIES

NEW PROCESSES, MATERIALS AND EQUIPMENT FOR THE METAL INDUSTRY

Continental Enters New Fields

The Industrial Equipment Division of the Continental Roll & Steel Foundry Company, East Chicago, Ind., has announced the acquisition of the Howell Engineering Co., St. Charles, Ill., manufacturers of Automatic Polishing and Buffing Equipment made under the B. F. Bower patents and patents pending. The engineering, service and sales staffs have also been absorbed.

Complete production of these products, which will henceforth carry the name "Continental," will be at the company's East Chicago Plant; the Coraopolis, Pa., and Wheeling, W. Va., Plants concentrating on the company's products for the steel and other industries, and steel castings in general.

Automatic Polishing and Buffing Machinery includes automatic work holders and chucks for high production polishing and buffing of parts with polishing surfaces on several planes such as vessels and spherical, circular or symmetrical pieces, irregular pieces, small intricate parts and straight or tapered tubing. Those machines feature foot pedal control, leaving the operator's hands free to pick up the next piece from the shelf, skid or tote box.

Other equipment in the line includes multiple chuck machines which permit removal and replacement of finished work while other work is being polished; reciprocating tables for polishing flat, capped or headed objects; and multi-head continuous tubing, molding and strip polishing machines with automatic composition applicators.

While there are many standard machines in the line which will meet the needs of numerous manufacturers, special machines involving the Bower principles will be developed to meet unusual requirements.

H. W. Faint, who is well known in the industry, having long been associated with metal polishing and buffing equipment, will head up the sales department of this unit of Continental's Industrial Equipment Division.

Plant operation of new polishing machines with foot pedal control.

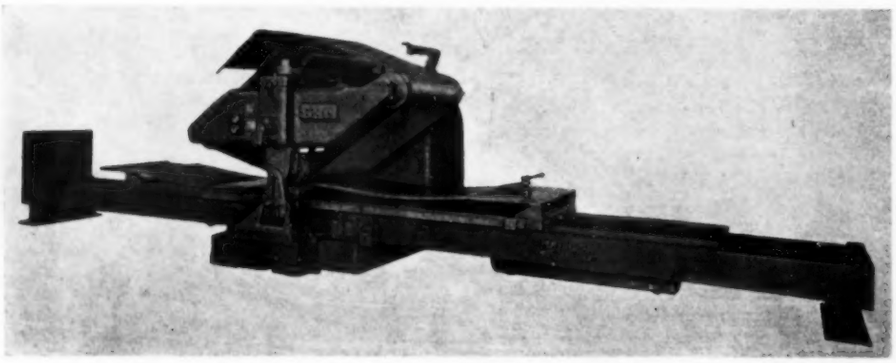
Wide Belt Sheet Grinding and Polishing Machine

The Mattison Machine Works, Rockford, Ill., have announced the Mattison No. 455 wide belt sheet grinding and polishing machine, especially designed for the proper application of factory coated abrasive belts to the grinding of stainless steel and other alloy sheets. According to the manufacturers, it is built with precision and care, and has the necessary weight to assure the stability required for smooth surfacing.

In addition to producing a fine and uniform finish, the machine, it is stated, has been designed with the particular object of securing the highest efficiency and longest life from factory-coated abrasives.

Construction adapts itself for quick application of belts, the abrasive belt being automatically controlled and oscillated on the rolls. Push button stations and controls for tables are located at front of machine for easy access by operator. Contact rolls are removable and rolls of any degree of cushion may be easily substituted according to the nature of the work.

This machine can be furnished in various widths and lengths, and is built to carry belts up to 40″ or 50″ wide, processing sheets up to 36″ or 48″ wide and 10′, 12′ and 14′ long.



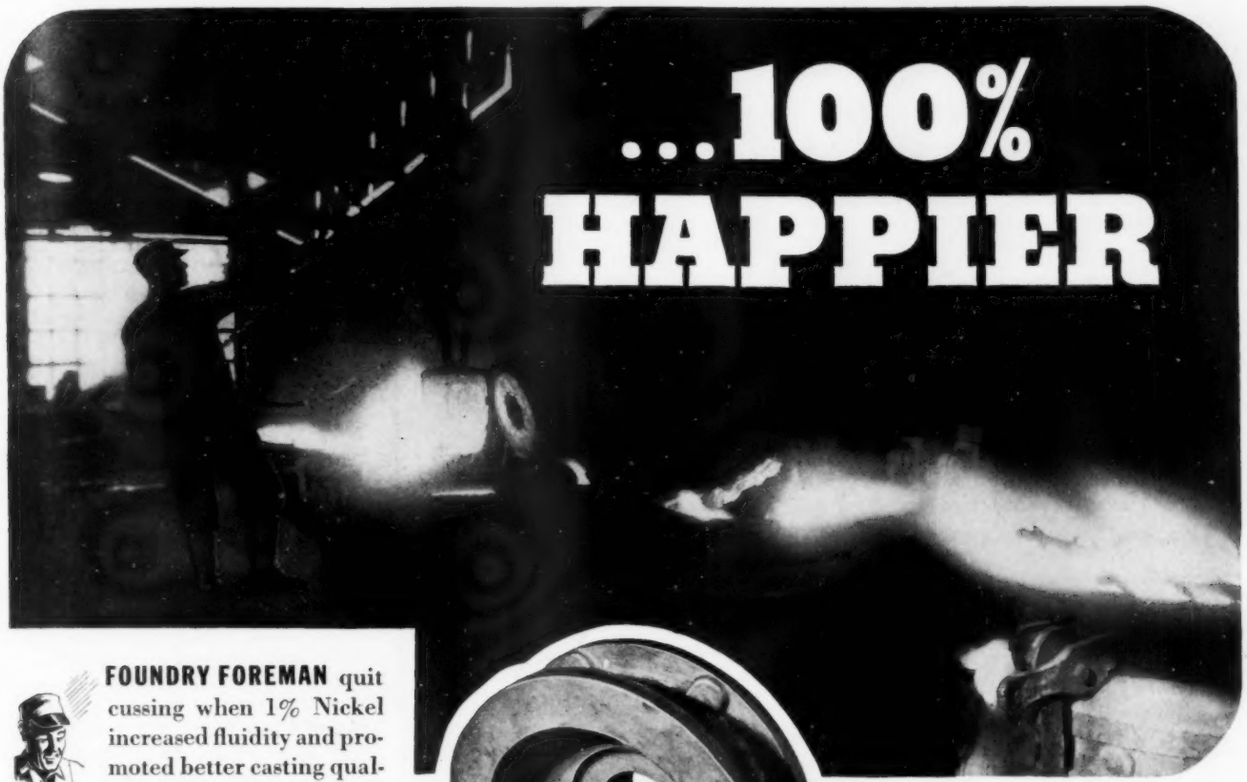
Wide belt sheet grinding and polishing machine.

New Small Universal Filter

A small all-purpose filter—the new Seitz Universal Line Filter, Type J G—has been announced by the American Seitz Filter Corporation, of Paterson, N. J. The overall dimensions of the filter proper are: height 7¾″; diameter of base 5½, which includes outlet, inlet and drain cock. Unusual volumes are said to be obtained with this small filter: water, with 2 to 3 lbs. pressure, 100 gallons per hour; with 25 lbs. pressure, more than 300 gallons per hour. Of course, the more viscous the liquid, the slower the flow. Pressures up to 50 lbs. may be used. It is adaptable to any filterable liquid, with filtering media best suited to a particular liquid; or for straining viscous liquids, using only the outer screen in the proper mesh.

The new Seitz J G is designed with 2 inner cylindrical screens, having a ¾-inch space between them. This space is filled with the desired grade of loose asbestos, pulp, charcoal, or other filtering agent. It

1% NICKEL *made 'em...*



FOUNDRY FOREMAN quit cussing when 1% Nickel increased fluidity and promoted better casting qualities from heat to heat.

BOSS started smiling when rejects stopped eating profits – no foundryman ever gets rich on rejects. Nickel added to bronze assures pressure tightness, increases tensile and compression strength, adds hardness with little or no loss in ductility; simplifies machining.

CUSTOMER relaxed when these Nickel bronze castings for locomotive boiler feed pumps withstood required pressure tests—and were sound and dense throughout.

CONSULTING ENGINEER beamed when finished Nickel bronze castings held pressures and, despite high temperatures, "proved satisfactory in every way."

PRESSURE-TIGHT CASTINGS

These locomotive boiler feed pump castings were produced of a Nickel bronze composition:

COPPER	85%
ZINC	5%
LEAD	5%
TIN	4%
NICKEL	1%

Castings by Textile Machine Co., Reading, Pa., for J. S. Coffin Jr. Co., Englewood, N. J. E. L. Schellans, Consulting Engineer.

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BRONZES

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Recognized as the world's largest manufacturer of chromium chemicals, Mutual brings to the plating industry a basic source of chromic acid.

Our facilities cover every step in its production, from the mining of the chrome ore on a remote island in the Pacific to the wide distribution of the finished product through warehouse stocks in the principal consuming centers.

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Mines in New Caledonia
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Warehouse stocks carried in all principal cities.

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270 Madison Avenue, New York City

is solidly packed by means of a wooden cylinder with the same diameter as the space between the screens. The inlet is through the inside of the inner cylindrical screen. The liquid is forced first through the inner screen, then through the filtering material and the outer screen, collecting in the outside shell and passing to the outlet. For liquids that require straining, no filtering media is used, the inner screen is omitted, and the outer screen is made of any desired mesh, up to 400.

New universal filter.

The filter area is about ½ square foot when the inner and outer screen are used with filtering material packed in; when only the outer screen is employed, the filter area is about ¾ square foot.

The filter may be attached directly to any pipe line with proper valves, so that the liquid may go either through the filter or directly through the line. The filter may be ordered with flat cast iron base, pump, motor, and by-pass arrangement for regulating pressures as shown in illustration.

Larger sizes are available on special order, the filter unit being increased in height but not in width. However, it is recommended that a multiple of units be placed on the same base, with one motor and one pump serving the various units in tandem. In this way, all the units may be used to produce higher volumes, or one or more may be cut out.

The standard construction is tinned bronze with monel screening, but the materials may be varied according to requirements.

Face Shields

A bulletin covering a new line of face-shields, which are now being widely used to protect workers from dust, sparks, heat, and glare, has been published by the Davis Emergency Equipment Company, 55 Van Dam Street, New York City.

The line described in the bulletin consists of four different types of face shield, ranging from a light weight, visorless shield to a shield with a fiber visor that protects the front part of the head from lacerations and bumps. All types are provided with replaceable transparent Plastacele windows which resist heat, acids, and caustics and are furnished in clear, green or amber colors.

New Spraying Units

The Electric Sprayit Co., 220 N. Broadway, Milwaukee, Wisc., has developed the Sprayit series 200 paint spraying units. These units, which are compact and easily portable, claim to combine high efficiency with low cost thereby meeting the requirements of all classes of users of this equipment.

They are used for general maintenance painting in offices, factories, stores, public buildings, apartments, hotels, homes, etc., as well as for product finishing in manual training classes, home work-shops and innumerable other localities. In addition, these units are used for refinishing work on automobiles, trucks, tractors, radios, refrigerators and furniture, as well as for small production work in industrial plants.

Portable spray unit.

The compressor is mounted on a heavy sheet steel base, fitted with rubber bumpers, and is V-belt driven by a ¼ H.P. electric motor. If desired, the unit can be furnished without motor, and operated either from a motor or line shaft, belt and pulleys for this purpose being furnished.

This compressor is of the diaphragm type which seals off the crankcase from the cylinder head, and thereby prevents any contamination of the compressed air by oil. The displacement of this compressor is 2.55 c.f.m., and the spraying pressure on the spray gun is over 30 pounds. Operation is smooth and vibrationless and the com-

pressed air is free from pulsations, it is reported.

The diaphragm used in this compressor is made of Neoprene firmly backed by fabric in a cord construction and is practically indestructible.

The spray gun is of the pressure feed internal break-up type and is fully adjustable. The gun body and removable cover are made of die cast aluminum and the container is of one-quart capacity and made of aluminum.

Three internal mix spray nozzles, for round, fan and angle sprays, are furnished with the gun, all nozzles and the fluid tip being made of case-hardened steel, to prevent wear.

The spray gun will deliver a spray up to 8" wide which permits the coverage of from 100 to 1200 sq. ft. per hour.

Welding Compound

The Wayne Chemical Products Co., 9501 Copeland Ave., Detroit, Mich., has recently introduced two coatings, identified as Spatter-Ex and Flash-Ex, to prevent the bonding of spatter and flash in welding operations. Both compounds are soluble in water.

The Spatter-Ex compound is transparent and of light jell consistency. It is used on the part to be welded and is reported as being effective in either arc, flash or butt welding. The Flash-Ex compound, which is white and pigmented, is intended principally to be used with resistance welding to prevent the dies and welding jaws becoming jammed with spatter and with non-ferrous metals having greater heat conductivity than steel.

With the use of these compounds—both of which have been thoroughly tested in production use—it is said to be unnecessary to grind or chip weld-spatter from the metal surrounding a weld. After the welding operations have been completed, any spatter which might still be resting on surrounding flat surfaces is merely brushed off. No extra work is involved in cleaning up the product which has been welded and the length of life of dies and welding holder jaws is increased materially.

DEPOSIT IS BETTER
PLATING IS EASIER

By test and by experience, many skilful platers know that Harshaw's Anodes and salts deposit better metallic finishes . . . They depend on Harshaw Quality for maximum ductility, rust resistance and attractiveness of their finishes. Harshaw products help to eliminate rejects and interruptions in production . . . Harshaw exact quality anodes and salts, simplifies your operations and makes plating easier.

THE HARSHAW CHEMICAL CO.

Manufacturers, Importers, Merchants
Offices and Laboratories: Cleveland, Ohio
Quality products since 1892

New York, Philadelphia, Chicago, Detroit, Pittsburgh, Cincinnati, East Liverpool, Los Angeles, San Francisco
Works at Cleveland & Elyria, Ohio & Philadelphia, Pa.

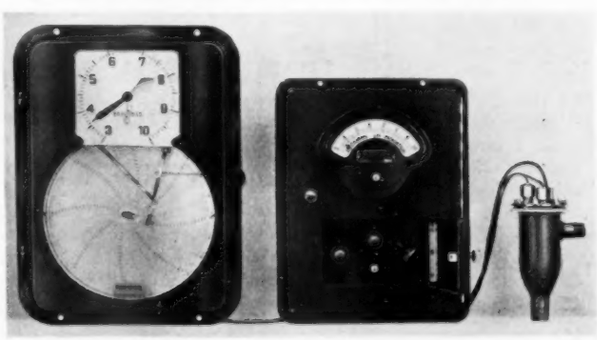
New Line of pH Recording and Controlling Instruments

A new line of pH Recorders and Controllers has just been announced by The Bristol Company, Waterbury, Conn. These instruments employ the glass electrode method of measurement and are designed especially for industrial plant use. They are offered in two general types: wide strip-chart model and the round-chart model. Automatic controllers are offered in both electric and air-operated models.

The instrument can be plugged into any standard light circuit, fluctuations in the line voltage being automatically compensated for.

Shielded glass and calomel electrodes are used for measurement and control. The shielded glass electrode is completely sealed and internally shielded from electrostatic interference. The companion calomel electrode has a factory-filled internal assembly, immersed in a saturated potassium chloride solution contained in the outer tube of the electrode. Electrolytic connection between the internal assembly and the solution under measurement is maintained through a small hole protected by a ground glass sleeve.

Two types of electrode assemblies are offered: (1) The Enclosed Flow Type (solution under measurement is pumped or allowed to flow through the chamber) and (2) Immersion Type (designed for immersion in tanks and vats). They are of a size that is convenient to handle and are rugged enough so as to require no special handling precautions. They can be used in viscous or semi-solid substances and in rapidly circulating or flowing liquids. Temperature changes are automatically compensated for. The company's bulletin 536 gives more information.



pH Recorder and Controller.

A SUCCESSFUL BRIGHT NICKEL PLATING INSTALLATION REQUIRES A PROVEN CLEANING PROCESS.

DO NOT WAIT FOR OLD CLEANING METHODS TO FAIL.

SAVE TROUBLE AND TIME BY IMMEDIATELY ADOPTING THE

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FREDERICK GUMM CHEMICAL CO.
INCORPORATED
538 Forest St., Kearny, N. J.
Western distributor
BELKE MFG. COMPANY, 947 N. Cicero Ave.
Chicago, Ill.

New Aluminum Paint

Following extensive tests covering a period of three years the paint engineers of the American Asphalt Paint Co., 43 E. Ohio St., Chicago, Ill., have announced a successful combination of 99.5% Gilsonite asphalt and special Valdura processed tung oil base with a fine aluminum paste and produced a ready-mixed aluminum paint that is said to require no special mixing, but can be applied directly as it comes in the container.

Both accelerated as well as outdoor weather tests prove, the manufacturer states, that Valdura's ready-mixed formula is equally as durable as regular Valdura asphalt aluminum paint. It is particularly suitable for those who prefer speed and convenience. This is particularly of interest in view of the fact that early attempts at ready-mixed aluminum paint formulation were practical for interior use only.

The production of a practical ready-mixed aluminum paint automatically overcomes the inconvenience of mixing enough paste and vehicle for only a day's painting. It saves time and bother of stirring the paste into the vehicle and is said to prevent any danger of an improper proportion of paste and vehicle being used.

Manufacturers' Literature

Building Maintenance. This is the second edition of the Flexrock handbook, and is based upon the same principle as the first edition, but increased in the amount of technical data and information for saving costs and maintenance of buildings. A "problem index" is included. Flexrock Co., 2301 Manning St., Philadelphia, Pa.

Cadmium Plating. A booklet describing Cadalyte maintenance compound and Cadalyte brightener for cadmium plating with Cadalyte plating salts. The combination of addition and brightening agents with sodium cyanide into one dry material, maintenance compound, claims more efficiency in the plating room. E. I. duPont de Nemours and Co., Inc., Electroplating Div., Wilmington, Dela.

Cement. Pamphlet No. 4. on *Asplit* which is said to be a self-hardening, acid-proof cement. It is made into a mortar by mixing only two ingredients—Asplit cement powder and Asplit cement solution. Pennsylvania Salt Mfg. Co., 1000 Widener Bldg., Philadelphia, Pa.

Chemicals. A booklet on aqua and anhydrous ammonia with particular reference to effective handling, first aid and pertinent data. Pennsylvania Salt Mfg. Co., 1000 Widener Bldg., Philadelphia, Pa.

Cleaners. Pennsalt—concentrated cleaners for industry. This folder contains typical uses and technical features of these cleaners. Pennsylvania Salt Mfg. Co., 1000 Widener Bldg., Philadelphia, Pa.

Cleaning. May-June issue of Oakite News Service featuring an illustrated article on "The Cleaning of Polished Steel Before Plating." Oakite Products, Inc., 22 Thames St., N. Y. City.

Cleaning. Bulletin No. 211 devoted to standard and auxiliary Rotoblast cleaning tables, describing the Airless cleaning of flat and fragile work such as stove parts, meter boxes, battery grids, shovels, switch parts, automotive parts, etc.; also sanitary ware, enameling work and other parts requiring cleaning. Pangborn Corp., Hagerstown, Md.

Cleaning. To those interested in the washing, rinsing, drying and burnishing of metal parts, the catalog, "Cleaning Machinery for Metal Parts," will be of value. A number of illustrations of the application of custom built equipment are shown as well as standard installations in well-known plants of automotive, electrical, radio and other metal working industries. N. Ransohoff, Inc., 202 W. 71st St., Cincinnati, Ohio.

Corrosion. A booklet on "Corrosion in the Refrigeration Industry" contains the following chapters: Chromate Treatment of Brine, Brine Testing, Treating Brine, Alkalinity Testing for Ammonia, Preparing New Brine, Maintaining the Chromate Concentration, Idle Freezing Tank, Clear Brine and Chrome Irritation. Mutual Chemical Co. of America, 270 Madison Ave., N. Y. City.

Die Casting. Printed matter on Pressure Die Casting Machine Model 200: Fully hydraulic and self-contained. For die casting of zinc, aluminum and brass alloys. Dycast Products Div., Monarch Aluminum Mfg. Co., Detroit Ave. & W. 93rd St., Cleveland, Ohio.

Gas Masks. A bulletin on the "Care and Use of Gas Masks" is being distributed by the Davis Emergency Equipment Co., 55 Van Dam St., New York City. This bulletin should be of interest to all industrialists concerned with the respiratory protection of workers as it covers the important points to be observed in selecting, testing, using and caring for several types of gas masks used in industry and their accessories.

Grinding Wheels. Facts about Grinding Wheels, a booklet containing the following: Part I. Grinding and Grinding Wheels; Part II. Reference Tables, Wheel Selection; Part III. General Grinding Information, including Definitions of Grinding Terms. Norton Co., Worcester, Mass.

Hardness. Printed matter entitled, "Hardness Conversion Table for Nickel Alloy Steels (revised)." International Nickel Co., Inc., 67 Wall St., N. Y. City.

Humidity Recorders. Bulletin No. 525 on humidity recorders and controllers for air conditioning, heating and drying processes manufactured by The Bristol Co., Waterbury, Conn. Information is given regarding Bristol's Wet- and Dry-Bulb Psychrometers, with illustrations of the various types of fixtures available to meet the requirements of the application.

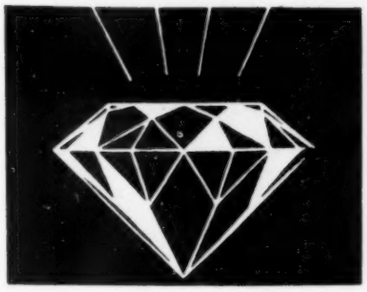
Kettles. A folder on electrically heated kettles made in a variety of sizes for a number of different uses ranging from 3 to 1,000 gallons. They are designed particularly for melting glues, waxes, cements and compounds. Harold E. Trent Co., 618 N. 54th St., Philadelphia, Pa.

Metallizing. Mogul metallizing guns. A booklet giving details on metal spraying, with new pictures and applications, listing equipment necessary for such work. Also a bulletin on Propane-Mogul. The use of propane in this new gun reduces, it is claimed, gas costs and increases speed of deposit. Metallizing Co. of America, Inc., 1351 E. 17th Street, Los Angeles, Calif.

Paints. "Improved Maintenance of Metal Surfaces with Zinc Dust Paints." A booklet devoted to rust inhibitive paint. Among the subjects covered are: the why and where of zinc dust paints; zinc dust paints for galvanized iron and sheet zinc; zinc dust paints as primers for aluminum paints and other types of finishing paints; colored zinc dust paints are both decorative and rust inhibitive. New Jersey Zinc Co., 160 Front St., N. Y. City.

pH. A bulletin discussing Bristol's pH instruments. With the equipment referred to in this bulletin, hydrogen-ion concentration, it is claimed, may be placed under the same close control as that of other process variables. Bristol Co., Waterbury, Conn.

Pickling. A folder on *Rodine*—pickling inhibitor. Among the advantages claimed are: clean metal is not wasted in pickling; acid is not wasted in destroying good metal; smooth, bright, clean surfaces are produced; the metal is not pitted or "burned." American Chemical Paint Co., Ambler, Pa.



WHO KNOWS?

Your unfinished product may be a "diamond in the rough"—but few buyers will appreciate it in this form. Capitalize the merit of your product FULLY by specifying a coating which does it justice. Remember, you know what's underneath —but buyers usually judge by what they SEE. Stanley Coatings can help you cut finishing time, reduce finishing costs, and improve the salability of your product. Write Department G—

THE STANLEY CHEMICAL CO.
EAST BERLIN CONNECTICUT
Lacquers · Enamels · Synthetics · Japans
A SUBSIDIARY OF THE STANLEY WORKS, NEW BRITAIN, CONN.

Pipe. A catalog entitled, "Toncan Iron Pipe for Tough Service," covering such subjects as the electric weld process of manufacture, rust and corrosion resistance, recommended applications, details of various tests, physical properties, threading procedure, welding, sizes and weights, etc. Republic Steel Corp., Advertising Div., Cleveland, Ohio.

Pyrometers. Bulletin No. 528 on strip-chart pyrometers. A section from a typical chart record made on a Bristol's multiple-record pyrometer is shown. It is said that eight temperature records, with identifying numerals and colors may be obtained with these instruments, and they are for temperatures up to 3000°F. The Bristol Co., Waterbury, Conn.

Polishing. "Semi-Automatic Polishing and Buffing Equipment." A folder describing the new Continental machines for rapid polishing and buffing. Air head operation is said to maintain uniform pressure of work to the wheel, and out-of-round contoured parts are processed without expensive cam or other devices. Continental Roll & Steel Foundry Co., Industrial Equipment Div., East Chicago, Ind.

Rack Coating. A folder describing Rack Coating-W of United Chromium, Inc., 51 E. 42nd St., N. Y. City, a material which has been developed primarily for the purpose of coating plating racks of all descriptions without being attacked by boiling cleaners or general plating solutions including chromium. It is white in color.

Sander. A circular on the "Easy" sander, which claims to replace slow, expensive hand-block sanding, rubbing or polishing on metal, wood, stone, leather and composition surfaces. Also it is said to sand out under-

EGYPTIAN
ZINC CHROMATE PRIMER

Bridges imperfections in metal . . .

Lays smooth . . .

Excellent spreading capacity . . .

Saves costs in time and baking . . .

Rust inhibiting . . .

For exterior or interior use . . .

Spray, dip, brush, or roller coat.

Further details of this exceptional undercoat gladly furnished upon request.

THE EGYPTIAN LACQUER MFG. COMPANY
ROCKEFELLER CENTER, NEW YORK

coats, "feathers" spot jobs, removes paint or rust and does lacquer, enamel or varnish finishing. Detroit Surfacing Machine Co., 7433 W. Davison St., Detroit, Mich.

Shears. Bulletin No. 71-G illustrating and describing Niagara series 100, 10 and 500 power squaring shears including several recent improvements. Niagara Machine and Tool Works, 637 Northland Ave., Buffalo, N. Y.

Solder. A booklet describing Alumaweld flux and solder for use in soldering aluminum, cast iron and die castings as well as all other metals.

Superfinishing. A folder entitled, "Superfinishing with Norton Machines (licensed by Chrysler Corp.), Stones and Wheels." Norton Co., Worcester, Mass.

Thermometers. Bulletin 529 on strip-chart resistance thermometers, which are claimed to make eight temperature records simultaneously on one chart. These instruments provide for identifying numerals and colors for the records, and are for temperatures between —40°F. and +300° F. The bulletin also shows a section from a typical chart with records and gives information regarding the company's resistance thermometer bulbs. The Bristol Co., Waterbury, Conn.

Transmissions. A folder describing and illustrating *JFS-Jr.* vari-speed controls, including selection tables. Columbia Vari-Speed Co., Liberty Bldg., Wheaton, Ill.

Voltmeter. Bulletin 538 describing new portable voltmeter for outdoor survey work, and rough handling. The Bristol Company, Waterbury, Conn.

Welding. A booklet discussing *McKay* certified stainless electrodes. The McKay Co., Pittsburgh, Pa.

Personals

A. Fred Norgren, recently elected vice-chairman of the International Fellowship Club at the meeting in Asbury Park, N. J., on June 19, was born in New Jersey.

His career in plating began early, at the age of 14 years, and he continued at this profession for about 34 years. During this time, he had a wide experience in various phases of plating and metal finishing and for 17 years was employed as foreman of plating by the Remington Typewriter Company. The last 11 years of this time, Fred was consultant for all of the plants of that company. He planned, installed and operated the plating and polishing departments of the Lincoln Motor Co., when the automobile was first introduced. After that he was in the job plating business for 2 years, following which he became associated with the Eager Electric Co., Watertown, N. Y., as sales and service man. For the past 15 years, Fred has been manager of the New England branch of Frederic B. Stevens, Inc.

He has taken an active part in the activities of the Bridgeport Branch of the American Electroplaters' Society and several years ago, transferred to the New Haven Branch where he is still a member.

His many friends in industry wish him every possible success in carrying out the duties of his new office.

H. Y. Bassett, a graduate engineer, has joined the staff of the *Wolverine Tube Company,* Detroit, Michigan, as Research Engineer.

Prior to going with the Chase Brass & Copper Company at Waterbury, about ten years ago, Mr. Bassett had a lengthy experience in the copper and zinc mines and smelters of Mexico and the Southwest. Mr. Bassett spent two years in the research department handling casting shop and mill procedure problems, working on casting developments, etc. When the Chase Company completed their new mill at Cleveland, in 1930, Mr. Bassett was made Assistant Metallurgist and spent seven years there handling mill procedure and developing sales promotional work. Mr. Bassett left the Chase organization in 1937 and went with the Surface Combustion Corporation, Toledo, in charge of sales of industrial furnace equipment to the non-ferrous industry.

J. Alfred Curtis, a graduate of Ohio State University, and formerly control chemist with Basic Dolomite, Incorporated, Maple Grove, Ohio, has joined the staff of *Battelle Memorial Institute,* industrial research organization of Columbus, Ohio. Mr. Curtis has been assigned to the analytical laboratory which, besides acting as a service department to the other Institute divisions, carries on research in methods of chemical analysis.

Mr. Curtis is a member of the American Chemical Society.

Frances M. Suarez Honored

At the 35th annual convention of the Advertising Federation of America, held in New York, June 19, *Miss Frances M. Suarez*, advertising manager of the Philadelphia Quartz Co., Philadelphia, Pa., was awarded a certificate of merit, being honorable mention for her contribution to advertising during the year 1938. This award in the Josephine Snapp National Competition, was open to all advertising women of the country. The entry consisted of a written exposition covering Miss Suarez' work in 1938 and an exhibit of it.

Senator Arthur Capper made the presentation at the opening luncheon of the Advertising Convention.

Miss Suarez entered the employ of the Philadelphia Quartz Company as a stenographer and translator and began the study of their chemical products then. One notable contribution in the exhibit is the composition of technical difficult-to-understand-facts in simple, easy-to-read style. Miss Suarez' position as head of an industrial company's advertising department is unusual, as industrial advertising is ordinarily considered a man's profession.

Miss Suarez was the first woman member of the Eastern Industrial Advertisers, Philadelphia Chapter of the National Industrial Advertisers Association, and has served as its secretary since 1935.

H. Y. Bassett, formerly in charge of sales of industrial furnace equipment to the nonferrous industry for the Surface Combustion Co., Toledo, Ohio, has joined the staff of the Wolverine Tube Co., Detroit, as a research engineer. Prior to his connection with Surface Combustion, Mr. Bassett was identified with the research and metallurgical department of Chase Brass & Copper Co.

Henry A. Weyer, engineer, formerly connected with the Nazel Engineering & Machine Works of Philadelphia, is now associated with the Chambersburg Engineering Company, Chambersburg, Pa.

C. Donald Dallas, President of Revere Copper and Brass Incorporated, has announced the appointment of *C. H. Kuthe* as Technical Advisor to the Company's Michigan Division.

Mr. Kuthe is an alumnus of Case School of Applied Science, Cleveland, Ohio, graduating as a B.S. in Mechanical Engineering in 1932, and securing his M.E. in 1937. Upon graduation he became associated with the Steel & Tubes Division of Timken Roller Bearing Company, acting first in the capacity of engineer in the development and manufacture of steel tubing, later in alloy steels. Two years prior to his appointment with Revere, Mr. Kuthe was acting in a sales and sales engineering capacity for Timken in the Philadelphia district.

Charles W. Thomas is Vice President and General Manager of Revere's Michigan Division with plant and headquarters office located at 5851 West Jefferson Avenue, Detroit, Michigan. Mr. Kuthe will operate directly with *Mr. Thomas* and *W. W. Roach*, Industrial Sales Manager.

How About Your Polishing and Buffing?

Is It Too Slow?

Too Costly?

Switch Over to Acme!

Ten chances to one, you can solve your problem with an Acme Automatic—increasing production, reducing costs, and turning out a more uniformly finished product.

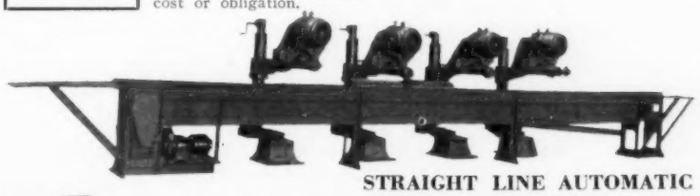
Take, for example, the machine shown at the right. With a head that can be adjusted vertically, horizontally or angleways for cross-cutting, it can be used in conjunction with straight line, rotaries, ends of rolling mills and other types of holding equipment.

Adjustable Floating Head POLISHING LATHE

What's Your Problem?

Acme Machines are made in many different types — each one designed to handle a particular buffing or polishing operation more speedily and more economically. Tell us what's bothering you and we'll supply the answer—without cost or obligation.

Send Sample for **FREE** Production Estimate



Polishes or buffs grilles, mouldings, strips, etc.

STRAIGHT LINE AUTOMATIC

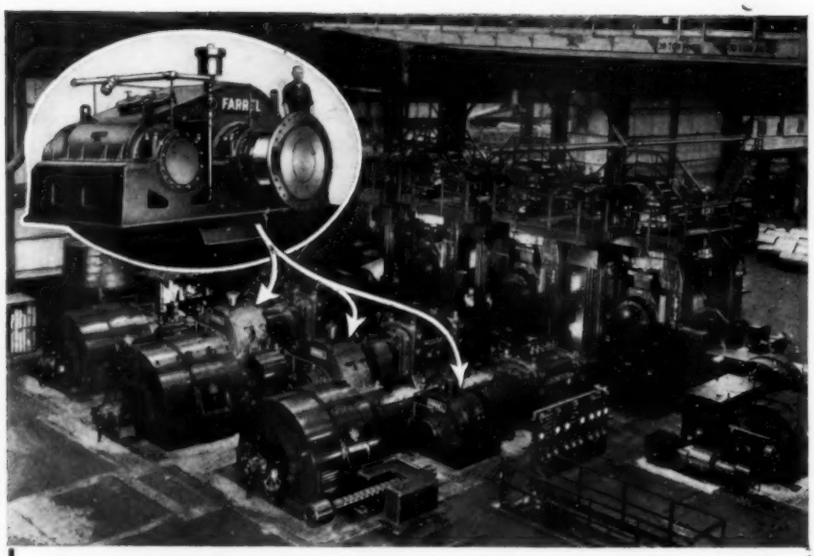
ACME Manufacturing Co.

1642 HOWARD ST. • DETROIT, MICH.

Builders OF AUTOMATIC POLISHING AND BUFFING MACHINES FOR OVER 25 YEARS

R. C. Enos, president of Standard Steel Spring Co., Coraopolis, Pa., announces the appointment of *Thomas N. Berlage* as director of sales for the Corronizing Division of the company. Corronizing is a new process for coating steel for corrosion protection. Mr. Berlage will assume his new duties with a rich background of sales experience with the Standard Engineering Co. and the Shell Oil Co. He is a graduate of the Massachusetts Institute of Technology where he earned the degree of B.Sc. in chemical engineering. He is 38 years of age, and his hobby is an 80-acre farm near Chicago.

Harry V. Mercer, advertising manager of the American Rolling Mill Company, Middletown, Ohio, was elected vice-president of the Porcelain Enamel Institute by the Institute's board of trustees in their meeting June 13 at Cleveland. *J. M. Seasholtz* of J. M. Seasholtz and Sons, Inc., Reading, Pa., was elected to P.E.I. board as a representative of the jobbing shop division of the Institute. The board set Nov. 16 and 17 as the dates of the annual meeting of the organization, to be held at the Pennsylvania Hotel, New York, N. Y.



FARREL GEAR UNITS

Drive 84" Tandem Cold Mill at New Irvin Works

In the new Irvin Works of Carnegie-Illinois Steel Corporation the 84" three-stand tandem cold reduction mill shown above is driven by three Farrel Gear Units. Two of the stands are powered by 2500 HP motors and the third by a 3500 HP motor.

These drives are typical examples of the advanced engineering and precision construction embodied in all Farrel Gear Units to assure efficient, economical, dependable performance under the most severe operating conditions.

All three drives are single reduction units with cases of all-welded steel construction which combine greater strength with less weight. Gears are continuous tooth herringbone, accurately generated by the Sykes process. Oil is supplied to gears and bearings by a central lubricating system. Built-in sprays lubricate the gears and the bearings are flood lubricated. To prevent oil contamination, dirt and moisture are trapped by breathers mounted on the covers.

Farrel Gear Units are built in any capacity for every type of service. When you have a drive problem ask to have a Farrel engineer consult with you on your requirements.

FARREL

FARREL-BIRMINGHAM COMPANY, Inc.
ANSONIA, CONN.
New York • Buffalo • Pittsburgh • Akron • Chicago • Los Angeles

Daniel B. Curll, Jr., has been appointed assistant to the president of the Rumford Chemical Works, Rumford, R. I. For the past nine years Mr. Curll has been chemist and technical adviser of the Philadelphia Quartz Co.

Samuel L. Hoyt, one of the foremost American metallurgists, has become a member of the staff of the Battelle Memorial Institute, Columbus, Ohio. Formerly director of metallurgical research with the A. O. Smith Corp., Dr. Hoyt will act as technical advisor in the planning and conduct of metallurgical research at Battelle, according to *Clyde E. Williams*, director. Dr. Hoyt is known particularly for his leadership in the development of cemented tungsten carbides for cutting tools and for his work on temperature-resistant alloys. Dr. Hoyt graduated from the Minnesota School of Mines, and studied at Columbia University and at the Charlottenburg Technical School, Germany. He received a Ph.D. degree from Columbia in 1914. He has been a director and active committee worker in the American Society for Metals, is a member of several committees of the American Institute of Mining & Metallurgical Engineers, and holds membership in the Institute of Metals and in the honorary scientific society Sigma Xi. He has written freely for the publications of these societies and for the technical press.

Verified Business Items

Bogus Subscription Agent

A notorious business magazine swindler, Raymond J. Palmer, alias Robert McArthur, has been operating in the midwest and far-west. Several people have fraudulently paid money to Palmer, supposedly for subscriptions to METAL INDUSTRY.

METAL INDUSTRY does not employ subscription solicitors of any sort, and it is recommended that all subscriptions be paid directly to the home office at 116 John Street, New York, N. Y.

Raymond J. Palmer has spent many years in jail for swindling activities. He is approximately 43 years old, 5′ 6½″ tall and weights about 185 pounds. He has chestnut hair, hazel eyes, medium complexion, flat obliterated scar on palm and inner hand, nose turned slightly to the right and a dimpled chin.

Linde Air Products Co., *Carbide and Carbon Chemicals Corp.* and *Haynes Stellite Company*, all of which are units of Union Carbide and Carbon Corp., are now located at 1517 Superior Ave., Cleveland, Ohio, occupying the entire building. District managers are *H. H. Dyar*, for Linde Air Products Co., *E. E. Fogle*, for Carbide and Carbon Chemicals Corp., and *F. P. Shephard*, for Haynes Stellite Co.

Day & Night Water Heater Co., Ltd., Monrovia, Calif., is installing a new galvanizing department. The company has also invested $40,000 in warehouse and manufacturing floor space. The total additions will amount to approximately 30% of the present floor space. Departments: pickling, stamping, brazing, welding, cleaning, enameling, finishing, galvanizing. Principal base metals used: steel and zinc.

J. Raymond Gill Co., Atlanta, Ga., has changed its name to Electroplating, Inc., same address as above.

Claud S. Gordon Co., 1988 E. 66th St., Cleveland, Ohio, announces the appointment of *N. A. Feldman* as office manager and purchasing agent.

Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., plans a one-story addition to branch plant at 2519 Wilkens Ave., Baltimore, Md., 41′ x 215′ to be used for light assembly operations. Cost over $65,000 with equipment.

Joseph T. Ryerson & Son, Inc., have purchased their Philadelphia plant property at 5200 Grays Ave., from the Taylor-Wharton Iron & Steel Co. This property had formerly been under lease. The company is making improvements and additions.

Deere & Mansur Works, Moline, Ill., agricultural equipment, are remodeling their present building. Departments: welding, grinding, tumbling, lacquering and enameling.

The Hobart Manufacturing Co., Troy, Ohio, will erect a one-story non-ferrous foundry building, also a three-story assembly building at an approximate cost of $100,000 less equipment.

National Electric Welding Machines Co., Bay City, Mich., has announced the appointment of *Leonard E. Nichols*, formerly chief welding engineer, as technical advisor and sales engineer for the Detroit district sales division, with headquarters in Detroit, Mich. *Julius R. Brueckner*, vice-president of the company, in charge of the Detroit district sales division, has removed his offices from the Stormfeltz-Lovely Bldg. to room 6-255 General Motors Bldg., with larger quarters for his staff of technicians.

The Association of American Steel Manufacturers Technical Committees, which formerly conducted research in steel technology, with headquarters at Pittsburgh, has been transferred to the Technical Committees of American Iron and Steel Institute. The standards for chemical compositions, physical properties, rolling tolerances, and other permissible variations from specified dimensions originally promulgated by the Association of American Steel Manufacturers Technical Committees will hereafter be sponsored by American Iron and Steel Institute, and will be published as a part of its Steel Products Manual.

L. Brewster Jackson has been appointed sales manager of Wickwire Bros. Inc., Cortland, N. Y., succeeding *G. H. Kennedy* who will remain with the company in an advisory capacity. Mr. Jackson has been associated with the concern for 14 years in the sales department covering southern and New England territories. His headquarters are at the main office in Cortland. He has had long experience in the wire business, previously having been associated with his father's firm, Jackson & Cook of Philadelphia. Mr. Kennedy has been associated with Wickwire Bros. for nearly 30 years.

Cutler-Hammer, Inc., Milwaukee, Wisc., has announced the appointment of *G. S. Crane* to vice-president in charge of sales and engineering. Previously, Mr. Crane was in charge of the sales division of the company. In addition to his sales responsibilities, he now assumes supervision of all of the development work for this company; also assumes executive control of the engineering and drafting departments as well as the company's patent department. He has been associated with the company for 29 years. Mr. Crane is well known for his work in the electrical industry and at the present time is chairman of the advisory committee of the industrial control section of the National Electrical Manufacturers Association, and was elected to the Board of Governors.

National Aircraft Corp., San Antonio, Tex., recently organized to succeed National Aircraft Co., has acquired about 63 acres near city for plant for manufacture of airplanes. It will comprise several one-story units for parts production and assembling. Cost close to $200,000 with equipment. *J. B. Miller* is vice-president and general manager.

Uncovering

THE FINEST COMMERCIAL BOND OBTAINABLE!

American Bonded Metals come to you *permanently* and *uniformly* finished. You stamp or form them—and stop there! No plating or polishing to be done. Thus no costly production delays and no reject troubles. You get *faster, finer* production—*at lower costs!* A free booklet—handsomely illustrated in color—shows all metals and scores of interesting applications. Write for it now—on your company letterhead, please.

ILLUSTRATED: *Paper-Adhered, a special covering that protects the brilliant finish during all handling and fabrication. Peels off as quickly and easily as a banana skin.*

AMERICAN NICKELOID COMPANY
8 Second Street, Peru, Illinois
Sales Offices in All Principal Cities

Agateen LACQUERS

All types of Clear Lacquer for Metals

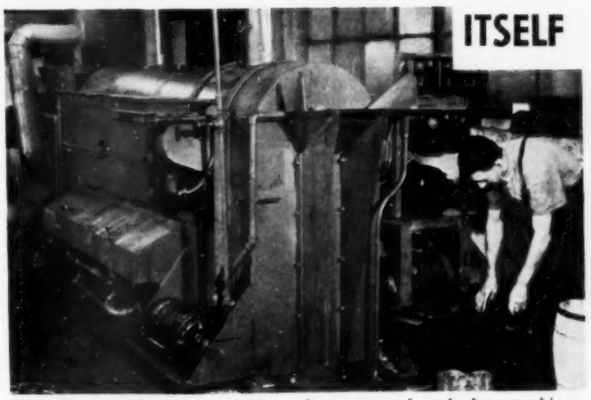
BUFFING LACQUER
for Cloisonne Reproductions
Air-Dry Priming Lacquer
Water Dip Lacquer

Elastic ***Non-blushing***

Agate Lacquer Mfg. Co., Inc.
11-13 Forty-third Road, LONG ISLAND CITY, N. Y.

Agateen —***The Last Word in Quality***

This Wash, Rust-proof and Dry Machine PAYS for ITSELF IN A YEAR



This is one of our standard wash, rust-proof and dry machines, consisting of soaking wash, spray wash, drain, oil spray, drain and dry. Will handle 900 lbs. of product per hour. For details of this and other Ransohoff Equipment, write for Catalog 40.

A nationally prominent bolt and nut manufacturer reports:

"Since installing the Ideal Continuous, wash, rust-proof and dry machine for metal parts, it has saved sufficiently to pay for itself in one year's operation. The work is finished better than with older methods, and at greater speed and considerably lower manufacturing cost."

IDEAL
TRADE MARK REG. U.S. PAT. OFF.

N. RANSOHOFF, INC. • 202 W. 71st Street, Carthage • CINCINNATI, OHIO

"Speedip"
WHIRL ENAMELER

Saves Time — Saves Enamel

● A combination dipping-whirling machine for completely coating large quantities of small parts with lacquer, enamel, paint, etc.

All operations are within the machine. Parts are dipped into coating material, raised and whirled. Time as little as 30 seconds. Speeds up production—cuts finishing costs—saves lacquers and enamels.

Write for further details or send samples to be coated.

RONCI MACHINE COMPANY
45 RIVER AVENUE • PROVIDENCE, R. I.

PERMAG
Cleaning Compounds

Nationally known manufacturing plants have solved their hardest metal cleaning problems with PERMAG CLEANING COMPOUNDS. Our compound for cleaning cold rolled steel produces the most satisfying results.

If you have a problem, put it up to our research department. Give PERMAG a chance at the tough cleaning jobs.

MAGNUSON PRODUCTS CORPORATION
Main Office and Factory
Third & Hoyt Sts. Brooklyn, N. Y.
Warehouses in Principal cities of the United States.
In Canada: Montreal and Toronto.

FILTERS *Portable or Stationary*

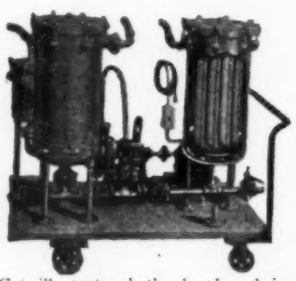
Capacity—200 to 2400 Gallons Per Hour

For:-
- NICKEL & BRIGHT NICKEL
- CHROMIUM
- ACID COPPER
- ZINC & BRITE ZINC
- CYANIDE COPPER & BRASS
- CADMIUM & TIN
- ELECTROCOLOR
- AND OTHER PLATING SOLUTIONS

— Also For —
DEGREASING SOLVENTS, CLEANERS, NEUTRALIZING SOLUTION, ETC.

Many important benefits are derived, and big savings effected in metal cleaning operations, as a result of filtration.

Industrial Filter & Pump Mfg. Co.
3017 West Carroll Avenue Chicago, Ill.



Cut illustrates both closed and internal view of typical filtering unit.

FILTERS for BRIGHT NICKEL are now offered in "Seven" new types and—"Eleven" different sizes.

For specific recommendations, mention kind of solution, number of gallons, etc. Write for our new bulletin and Descriptive literature.

Stanley Chemical Co., East Berlin, Conn., announces that *I. T. Darlington*, a well-known authority in the field of industrial coatings, has recently joined its technical organization. Mr. Darlington is a graduate of Lafayette College and did post graduate work at Columbia University. His chemical experience has always been in the field of organic chemistry. Following the war he was closely associated with the development of lacquers and lacquer materials with laboratory and technical experience in the manufacture of nitrocellulose and solvents. During the past eighteen years he has served in various capacities with some of the largest manufacturers of industrial coatings. Mr. Darlington joins the research and development staff of the Stanley Chemical under the direction of *E. M. Hayden*, technical director. His knowledge and experience will be devoted to the study of definite problems and the development of new materials for highly specialized products. He will also be available for sales service work.

Mount Clemens Metal Products Co., Mt. Clemens, Mich., small metal specialties for automobiles, has purchased property adjoining plant. The following departments are operated: extruding, stamping, cleaning, plating and tumbling. Principal base metals used: steel.

Bias Buff & Wheel Co., 430 Communipaw Ave., Jersey City, N. J., has been licensed by the Jackson Buff Corporation of Long Island City, N. Y., with full rights to manufacture under U. S. patents No. Re. 19,894 and No. 2,140,208 which have broad claims covering an air cooled buff having means for the admission of cooling air through the sides of the buff. Manufacturers of buffs are warned against infringement of the claims of these patents as the owners and the licensee intend to protect their rights under these patents and stop infringement. Also U. S. Patent 2,004,623. This ventilated feature in the manufacture of cotton polishing buffs fits in with the well known Bias construction and also with the conventional buff.

Electro-Motive Mfg. Co., Inc., 797 E. 140th St., New York City, manufacturer of radio parts and equipment, has leased 30,000 sq. ft. floor space in former mill of Rossie Velvet Co., Willimantic, Conn., and will improve plant. Entire business will be removed to new location and production increased.

Atlantic Brass & Copper Co., wholesale jobbers of metals, removed their office and warehouse to new quarters at 73 Warren St., New York City. They were formerly located at 593 Broadway, New York. Supervisor is *H. M. Schwartz*. The firm handles sheet aluminum, brass, copper, steel and zinc, and also circles in various sizes and metals.

Insuline Corp. of America, Inc., 23 Park Place, New York, manufacturer of electrical and radio equipment and parts, has leased about 12,000 sq. ft. of floor space in building at 30-30 Northern Blvd., L. I. City, N. Y., for plant. The following departments are operated: stamping, soldering. Principal base metals used: brass and steel.

President Raycroft of the *National Battery Manufacturers Association* announces the appointment of *V. L. Smithers* of Akron, Ohio, as the new commissioner of the Association succeeding *W. J. Parker*, resigned. Commissioner Smithers' headquarters will be 2706 First-Central Tower, Akron, Ohio. The appointment was voted by the Board of Directors during the spring convention at White Sulphur Springs.

The J. B. Ford Sales Co., Wyandotte, Mich., at the annual directors meeting, elected *C. B. Robinson*, president and *W. F. Torrey*, secretary-treasurer, both serving on the board of directors. Mr. Robinson has been connected with the organization in a sales and executive capacity for twenty-two years. Mr. Torrey has been actively connected with the firm for six years.

Patent Digest

(*Continued from page* 335)

Since the current passing through the electrolyte is a function of the ohmic resistance of the path between anode and cathode or the length of the path, it follows that those portions of the cathode nearer the anode will receive higher current densities than those farther away. Thus, theoretically, there will be a continuous variation and reduction of current density. The Patentee describes and gives plans for several other types of experimental plating tanks, all modifications of the original, with which the same purpose can be accomplished.

He lists as the possible advantages of this method of observation and experimentation:

1. It is useful in determining the bright plating range of a given electrolyte. Each unit strip of the cathode receives a different current density. At a point on the cathode where the deposit seems to be brightest, the current density can be determined by measuring the thickness of the deposit at that point. From the observed time of deposition, the thickness of the deposit and the assumed cathode efficiency of 100% (this can be determined correctly where more accurate results are desired), it becomes possible to complete the current density on the unit area chosen.*

2. For the reasons above stated, the apparatus is useful in rapidly determining the effects of various brighteners at different current density ranges.

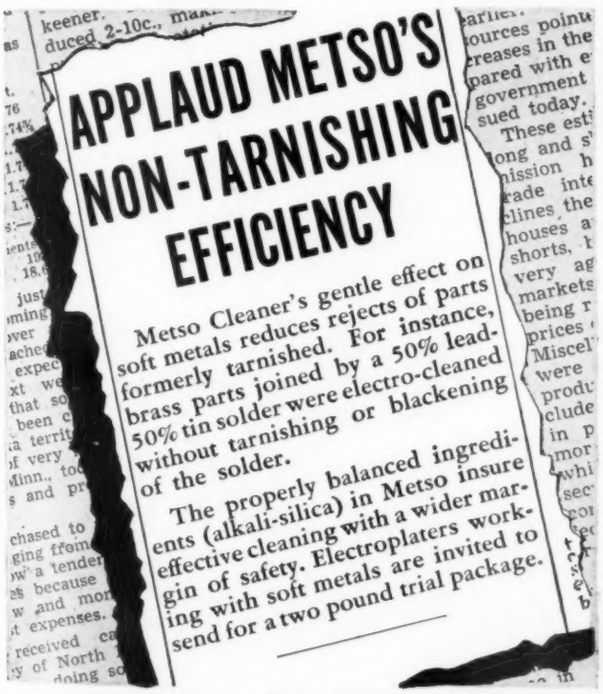
3. It is useful in determining the effects of varying the components and factors influencing the bath, such as metal salts, temperature, pH, etc. The observer is quickly able to estimate the magnitude of such effects at current densities varying from the highest to the lowest possible values.

4. It can be used as a throwing power meter by comparing the thickness of the metal deposited at a given point on the cathode with the thickness of metal deposited at the same point on a similar cathode, using a solution of zero throwing power, such as acid copper.

The inventor states, that in practice, the variation of current along the receding cathode is not linear because of the effect of eddy currents, edge, wall and point effects, etc., but by following the precautions outlined, such as sealing the edges of the cathode into the tank slots with a medium such as paraffine and using a stirring device, the effect of these disturbances in current flow can be disregarded for all practical purposes. He also states that in use the cathode should be so slanted towards the anode that the nearer edge receives sufficient current to cause burning of the deposit and the far edge receives barely enough current to cause deposition of the metal in question. In this way, the complete range of available current densities can be covered in one test.

*Faraday's Law states that the weight of metal deposited equals the electrochemical equivalent of the metal times the time of deposition times the current flowing during the interval; ie., W equals K x T x I and therefore I equals W/KT. But W equals the thickness of the deposit times the area considered times the density of the metal. Therefore

$$I \text{ equals } \frac{t \times A \times d}{K \times T}$$


APPLAUD METSO'S
NON-TARNISHING
EFFICIENCY
Metso Cleaner's gentle effect on soft metals reduces rejects of parts formerly tarnished. For instance, brass parts joined by a 50% lead-50% tin solder were electro-cleaned without tarnishing or blackening of the solder.
The properly balanced ingredients (alkali-silica) in Metso insure effective cleaning with a wider margin of safety. Electroplaters working with soft metals are invited to send for a two pound trial package.

METSO CLEANERS
PHILADELPHIA QUARTZ COMPANY
General Offices and Laboratory: 125 S. Third St., Phila., Pa.
Chicago Sales Office: 205 W. Wacker Drive. Stocks in 60 cities.
Sold in Canada by NATIONAL SILICATES LTD., Toronto, Ont.

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POLISHING GRAINS

1. CBT LIONITE
An etched grain built to withstand the shock and stress of rough work. Sizes 10-90 incl.

2. EPT LIONITE
An etched grain designed to prevent glazing. For operations where little self-dressing of the wheel occurs. Sizes 24-90 incl.

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GENERAL ABRASIVE CO.
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1869—SEVENTY YEARS SERVICE—1939
TO THE METAL WORKING TRADES
BUILDING THE BEST IN TANKS

WOOD TANKS
STEEL TANKS
LEAD LININGS
RUBBER LININGS

THE HAUSER-STANDER TANK CO.
4838 SPRING GROVE AVE. CINCINNATI, OHIO

The Patentee gives sample test results with the following two solutions:

Cadmium oxide	43 g./L
Sodium sulphate	60 "
Sodium cyanide	120 "
Nickel sulphate	1 "
Sulfite cellulose waste	10 "

Room temperature. By means of apparatus patentee finds that the bright range exists between 21-57 amperes per square ft.

Cadmium oxide	43 g./L
Sodium sulphate	60 "
Sodium cyanide	130 "
Cobalt sulphate	10 "
Nicotine	4 drops per liter

Room temperature. Bright range exists between 26-40 amperes per sq. ft.

2. *Methods of Pickling Metals*

American Patent No. 2,152,406. Granted March 28, 1939 to A. J. Ducamp and M. E. Alfred, France.

In ordinary acid pickling baths for the removal of tarnish and oxides from ferrous and copper containing metals, the products of reaction remain in suspension in the solution thus reducing its efficiency and making it impossible to regenerate it after a certain period of use. The inventors have patented a non aqueous pickling bath containing alcohols or phenols of the unsaturated or saturated aliphatic acids or mixtures of the same, in the presence of glycerides plus one or more of the stronger acids such as hydrochloric, phosphoric, acetic, formic, etc., which they claim obviates these difficulties.

Media such as the one put forth are immiscible with water and are of lower density than water therefore when water is formed by the interaction of the acid and the metal oxides, said water and solid reaction products will sink to the bottom and will be permanently removed from the field of action thus increasing the efficiency of the pickling bath and making it possible to replenish it day after day with fresh pickling liquid. The following composition is given as typical:

Undecylenic acid	10%
Anhydrous acetic acid	5%
Hydrochloric acid 22°	15%
Butanol	70%

The pickling time is 30 minutes at 65° C. Attack on the pure metal is negligible if up to 3% trioxmethylene is added as an inhibitor. With this compound present, the temperature must be kept at 60° C or below as it decomposes above this range.

2. Formula for the replenishing solution after use is:

Undecylenic acid	15%
Acetic acid (anhyd)	10%
Hydrochloric acid	65%
Butanol	10%

Losses due to evaporation of the pickle are replenished by a solution of the original composition.

3. *Nickel Plating Solution (Bright)*

Canadian Patent No. 380,041. Granted March 14, 1939 to Marcel Ballay, France. Assigned to International Nickel Corp.

The invention consists of a nickel solution containing nickel sulphate, an ammonium salt and a chloride, plus egg and (or) blood albumenoids selected from a group that is not coagulated at boiling temperatures in an aqueous 5% solution of nickel sulphate. The bath is operated at a pH of not less than 6.7, but not high enough to precipitate basic nickel compounds. The temperature given is 25°-55° C. Current density 2-6 amps./sq. dm.

4. *Metal Brightening Method (Bright Dip)*

Canadian Patent No. 380,242. Granted March 21, 1939 to G. K. Soderberg. Assigned to Udylite Inc.

A method for treating metals such as cadmium and zinc and brightening the same in (1) an acidified mixture of hydrogen peroxide, or (2) a mixture of hydrogen peroxide and perchloric acid. Recommended for cadmium are mixtures of peroxide and sulphuric acid of the following range of composition:

H_2O_2	0.8 to 4.5 Normal
H_2SO_4	0.06 to 0.35 Normal

5. *Phosphate Coated Ferrous Article Production*

Canadian Patent No. 380,329. Granted to G. C. Romig. Assigned to American Chemical Paint Co.

Ferrous metals are coated with a water insoluble phosphate coating by electrodeposition. Using the metal to be coated as an electrode, in a solution containing phosphate anions and cations of the metals of the class consisting of zinc, cadmium, nickel, cobalt, and manganese; subjecting the said electrode to a reversing or periodically alternating current and periodically adding a reagent for the removal of iron from the solution, said agent being of the class consisting of ferricyanide, permanganate, dichromate, hydrogen peroxide, nitrous acid or a salt of the latter. The concentration of iron in the electrolyte must be maintained around 0.25% by weight, and never permitted to exceed 0.6% by weight.

Metal Prices, June 28, 1939

(All quotations are based on wholesale quantities, prompt delivery, New York unless otherwise specified.)

New Metals

ALUMINUM, Virgin ingot, 99% plus, c.l.	20.00c.
ANTIMONY, Chinese, 99%	14.00c.
BISMUTH, Ton lots, American, 99½%	$1.10
CADMIUM, Sticks and bars, tons	50c.
COPPER, Lake, delivered Conn.	10.00c.
Electrolytic, delivered Conn.	10.00c.
Castings, F.O.B. refinery	9.525c.
GOLD, U. S. Treasury price, oz. Troy	$35.00
LEAD, Desilvered and Prime Western	4.70c.
MAGNESIUM, 99.95% ingot	30.00c.
MERCURY (Quicksilver), Flasks, 75 lb.	$90-$92
NICKEL, Ingot or Shot	36.00c.
Electrolytic, 99.95%, sheets	35.00c.
PLATINUM, oz., Troy	$35.00
TIN, Straits	49.00c.
ZINC, Prime Western	4.50c.
Brass Special	4.60c.
High Grade	5.50c.
Die Casting Alloy	7.50c.

Ingot Metals and Alloys

	Cents per lb.
No. 1 Yellow Brass	8.375
85-5-5-5	10.25
88-10-2	14.00
80-10-10	12.375
Manganese Bronze (60,000 t. s. min.)	10.375
Aluminum Bronze	14.625
Monel Metal Shot or Block	28
Nickel Silver (12% Ni)	12.375
Nickel Silver (15% Ni)	14.625
No. 12 Aluminum	13.00-15.00
Manganese Copper, Grade A (30%)	22-27
Phosphor Copper, 10%	15.00
Phosphor Copper 15%	15.50
Silicon Copper, 10%	21.50
Phosphor Tin, no guarantee	50-60
Iridium Platinum, 5% (Nominal)	$36.50
Iridium Platinum, 10% (Nominal)	$38.00

Old Metals

Dealers' buying prices, wholesale quantities:	Cents per lb.
Heavy copper and wire, mixed	6.875-7.00
Light copper	6.125-6.25
Heavy yellow brass	4.50-4.625
Light brass	3.50-3.625
No. 1 composition	6.125-6.25
No. 1 composition, turnings	5.875-6.00
Heavy soft lead	4.00-4.125
Old zinc	2.25-2.50
New zinc clips	3.00-3.25
Aluminum clips (new, soft)	13.00-14.00
Scrap aluminum, cast	6.50-6.75
Aluminum borings—turnings	4.50-4.75
No. 1 pewter	29.00-30.00
Electrotype	4.25-4.50
Nickel anodes	25.00-26.00
Nickel clips, new	27.00-28.00
Monel scrap	8.00-12.50

Wrought Metals and Alloys

The following are net BASE PRICES per lb., to which must be added extras for size, shape, quantity, packing, etc., or discounts, as shown in manufacturers' lists. Basic quantities on most rolled or drawn brass and bronze items below are from 2,000 to 5,000 lbs.; on nickel silver, from 1,000 to 2,000 lbs.

Copper Material

Sheet, hot rolled	18.12c.
Bare Wire, soft, less than carload	13.875c.
Seamless Tubing	18.62c.

Nickel Silver

Sheet Metal		Wire and Rod	
10% Nickel	25.25c.	10% Nickel	27.87c.
15% Nickel	26.62c.	15% Nickel	31.12c.
18% Nickel	27.62c.	18% Nickel	34.00c.

Aluminum Sheet and Coil

Base Prices Carload Lots (F.O.B. Mill)

Aluminum Sheet, 20 gauge	35.00c.
Aluminum Coils, 20 gauge	28.00c.

Rolled Nickel Sheet and Rod

Base Prices (F.O.B. Mill)

Cold Drawn Rods	50c.	Standard Cold Rolled Sheet	49c.
Hot Rolled Rods	45c.		

Monel Metal Sheet and Rod

Base Prices (F.O.B. Mill)

Hot Rolled Rods	35c.	No. 35 Sheets	37c.
Cold Drawn Rods	40c.	Std. Cold Rolled Sheets	39c.

Silver Sheet

Rolled Sterling Silver 45c. per Troy oz. upward according to quantity.

Brass and Bronze Material

	Yellow Brass	Red Brass 80%	Comm'l. Bronze
Sheet	16.48c.	17.25c.	18.25c.
Wire	16.73c.	17.50c.	18.50c.
Rod	11.85c.	17.50c.	18.50c.
Angles, channels, open seam tubing	24.98c.	25.75c.	26.75c.
Seamless tubing	19.23c.	19.90c.	20.65c.

Tobin Bronze and Muntz Metal

Tobin Bronze Rod	18.37c.
Muntz Metal Sheet	19.75c.
Muntz Metal Rod	15.87c.

Zinc and Lead Sheet

Zinc Sheet, carload lots standard sizes and gauges, at mill, less 7% discount	9.75c.
Zinc Sheet, 1200 lb. lots (jobbers' prices)	10.75c.
Zinc Sheet, 100 lb. lots (jobbers' prices)	14.75c.
Full Lead Sheet	7.75c.
Cut Lead Sheet	8.00c.

Block Tin, Pewter and Britannia Sheet

This list applies to either block tin or No. 1 Britannia Metal Sheet, No. 23 B. & S. Gauge, 18 inches wide or less; prices are all f.o.b. mill:

500 lbs. over	15c. above N. Y. pig tin price
100 to 500 lbs.	17c. above N. Y. pig tin price
Up to 100 lbs.	25c. above N. Y. pig tin price

Supply prices on page 352.

Supply Prices, June 28, 1939

Anodes

Prices, except silver, are per lb. f.o.b., shipping point, based on purchases of 2,000 lbs. or more, and subject to changes due to fluctuating metal markets.

COPPER: Cast	20⅜c. per lb.	NICKEL: 90-92%, 16" and over	.45 per lb.
Electrolytic, full size, 15⅜c.; cut to size	15⅜c. per lb.	95-97%, 16" " "	.46 per lb.
Rolled oval, straight, 15⅞c.; curved	16⅛c. per lb.	99%+cast, 16" and over, 47c.; rolled, depolarized, 16" and over, 48c.	
BRASS: Cast	17¼c. per lb.	SILVER: Rolled silver anodes .999 fine were quoted from 46c. per Troy ounce upward, depending on quantity.	
ZINC: Cast	10 c. per lb.		

Chemicals

These are manufacturers' quantity prices and based on delivery from New York City.

Acetone, C.P. l.c.l., drums	lb.	.06¼
Acid, Boric (boracic) granular, 99.5%, bbls.	lb.	.053-.059
Chromic, 99%, 100 lb. and 400 lb. drums	lb.	.16¾-.17¼
Hydrochloric (muriatic) Tech., 20°, carboys	lb.	.027
Hydrochloric, C.P., 20°, carboys	lb.	.08
Hydrofluoric, 30%, bbls.	lb.	.07-.08
Nitric, 36°, carboys	lb.	.06
Nitric, 42°, carboys	lb.	.075
Oleic (Red Oil), distilled, drums	lb.	.08⅜
Oxalic, bbls. l.c.l.	lb.	.12-.14
Stearic, double pressed, distilled, bags	lb.	.10½-.11½
single pressed, bags	lb.	.10-.11
triple pressed bags	lb.	.13½-.14½
Sulphuric, 66°, carboys	lb.	.025
Alcohol, Amyl, l.c.l., drums	lb.	.15-.165
Butyl-normal, l.c.l., drums	lb.	.09
Denatured, S.D. No. 1, 190 pf., bbls., works	gal.	.305-.315
Diacetone, pure, drums, l.c.l.	lb.	.095
Methyl, (Methanol), 95%, drums, l.c.l.	gal.	.385
Propyl-Iso, 99%, l.c.l., drums	gal.	.41
Propyl-Normal, drums	gal.	.70
Alum, ammonia, granular, bbls., works	lb.	.0315
Potash, granular, bbls., works	lb.	.034-.037
Ammonia, aqua, 26°, drums, carboys	lb.	.02¼-.05¼
Ammonium, chloride (sal-ammoniac), white, granular, bbls.	lb.	.05-.075
Sulphate, tech., bbls.	lb.	.035-.05
Sulphocyanide (thiocyanate), pure, crystal, kegs	lb.	.55-.58
Sulphocyanide (thiocyanate), com'l, drums	lb.	.16
Antimony Chloride (butter of antimony), sol., carboys	lb.	.13-.153
Barium Carbonate, ppted., l.c.l., bags, works	lb.	.03
Benzene (Benzol), pure, drums	gal.	.21
Butyl Lactate, drums	lb.	.225
Cadmium Oxide, l.c.l., bbls	lb.	.55
Calcium Carbonate (Ppted. chalk), U.S.P.	lb.	.05¾-.075
Carbon Bisulfide, l.c.l., 55 gal. drums	lb.	.05¾-.06
Carbon Tetrachloride, l.c.l., drums	gal.	.73
Chrome, green, commercial, bbls.	lb.	.22
Chromic Sulphate, drums	lb.	.26¼
Cobalt Sulphate, drums	lb.	.59
*Copper, Acetate (verdigris), bbls.	lb.	.25
Carbonate, 53/55%, bbls.	lb.	.14½-.15½
Cyanide, Tech., 100 lb. bbls.	lb.	.34
Sulphate, Tech., crystals, bbls.	lb.	.05
Cream of Tartar (potassium bitartrate), crystals, kegs	lb.	.23¼
Crocus Martis (iron oxide) red, tech., kegs	lb.	.07
Dibutyl Phthalate, l.c.l., drums	lb.	.195
Diethylene Glycol, l.c.l., drums, works	lb.	.155
Dextrine, yellow, kegs	lb.	.05-.08
Emery Flour (Turkish)	lb.	.07
Ethyl Acetate, 85%, l.c.l., drums	lb.	.066
Ethylene Glycol, l.c.l., drums, works	lb.	.17-.20
Flint, powdered	ton	30.00
Fluorspar No. 1 ground, 97-98%.	ton	$60.00
Fusel Oil, refined, drums	lb.	.125-.14
*Gold, Chloride	oz.	$18¼-23
Cyanide, potassium 41%	oz.	$15.45
Cyanide, sodium 46%	oz.	$17.10

*Subject to fluctuations in metal prices.

Gum, Arabic, white, powder, bbls.	lb.	.125-.14
Sandarac, prime, bags	lb.	.50
Hydrogen Peroxide, 100 volume, carboys	lb.	.20
Iron Sulphate (Copperas), bbls.	lb.	.016
Lead, Acetate (Sugar of Lead), bbls.	lb.	.10-.12¾
Oxide (Litharge), bbls.	lb.	.125
Magnesium Sulphate (Epsom Salts), tech., bag	lb.	.018
Mercury Bichloride (Corrosive Sublimate)	lb.	$1.58
Mercuric Oxide, red, powder, drums	lb.	$1.81
Nickel, Carbonate, dry, bbls.	lb.	.36-.41
Chloride, bbls.	lb.	.18-.22
Salts, single, 425 lb. bbls.	lb.	.135-.145
Salts, double, 425 lb. bbls.	lb.	.135-.145
Paraffin	lb.	.05-.06
Phosphorus, red	lb.	.42
yellow	lb.	.55
Potash, Caustic, 88-92%, flake, drums, works	lb.	.07¼-.075
Potassium, Bichromate, crystals, casks	lb.	.09¼
Carbonate (potash) 98-100%, drums	lb.	.06¾
Cyanide, 94-96%, cases	lb.	.525
Pumice, ground, bbls.	lb.	.03
Quartz, powdered	ton	$30.00
Quicksilver (Mercury) 76 lb. flasks	flask	$89.-$92
Rochelle Salts, crystals, bbls.	lb.	18.25
Rosin, gum, bbls.	lb.	5.25-7.75
*Silver, Chloride, dry, 100 oz. lots	oz.	.40¼
Cyanide, 100 oz. lots	oz.	.39⅝
Nitrate, 100 oz. lots	oz.	.35
Sodium Carbonate (soda ash), 58%, bbls.	lb.	.0235
Cyanide 96%, 100 lb. drums	lb.	.15
Hydroxide (caustic soda) 76%, flake	lb.	.0355
Hyposulphite, crystals, bbls.	lb.	.035-.065
Metasilicate, granular, bbls.	lb.	.0315
Nitrate, tech., bbls.	lb.	.029
Phosphate, tribasic, tech., bbls.	lb.	.027
Pyrophosphate, anhydrous, bbls., l.c.l.	lb.	.056
Sesquisilicate, drums	lb.	.0405
*Stannate, drums	lb.	.32½-.34½
Sulphate (Glauber's Salts), crystals, bbls., works	lb.	.0135
Sulphocyanide, drums	lb.	.30-.35
Sulphur, Flowers, bbls., works	lb.	.037-.0410
*Tin Chloride, 100 lb. kegs	lb.	.37½
Toluene (Toluol), pure, drums, works	gal.	.27
Tripoli, powdered	lb.	.03
Wax, Bees, white, bleached, slabs 500 lbs.	lb.	.36-.40
Bees, yellow, crude	lb.	.21-.215
Carnauba, refined, bags	lb.	.34½-.35
Montan, bags	lb.	.115-.12
Spermaceti, blocks	lb.	.23
Whiting, Bolted	lb.	.025-.06
Xylene (Xylol), drums, works	gal.	.31
Zinc, carbonate, bbls.	lb.	.14-.15
Cyanide, 100 lb. kegs	lb.	.33
Chloride, granular, drums	lb.	.06
Sulphate, crystals, bbls.	lb.	.04

Metal prices on page 351.